NOVEMBER 1959

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ILLUMINATING ENGINEERING

Journal of the
ILLUMINATING ENGINEERING SOCIETY

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NEW

UNITED ENGINEERING CENTER

COMING! And indeed it is coming — the new United Engineering Center, the beautiful building as shown, in color, on the reverse side.

Commencement of construction in early fall, 1959... Completion of construction by March, 1961... Ready for occupancy by July, 1961... these are the target dates for the new building.

The New United Engineering Center will rise and stand as a monument to a proud and noble profession. Just as its near neighbor, the United Nations on United Nations Plaza in New York City, stands as a symbol of world co-operation, the new United Engineering Center will stand as a symbol of engineering unity and co-operation in the United States. It will be the greatest center for engineering interests in the world. It will be a structure in which every engineer will have justifiable pride.

There is no question that the building will be built. But the drive for funds cannot be allowed to slow down. This message reaches you at a time when we have just passed the three-quarter mark in our fund campaign. The home stretch — and victory in this united drive — lie in the weeks ahead.

Now is the time for all campaign workers to make sure that all members of each section have at least been contacted. It is the time for all sections of all societies to strive for 100 per cent completion of their quotas. It is the time for those sections which already have reached their money goals to keep trying for 100 per cent membership contributions.

And it is also the time for those engineers who already have contributed to ask themselves: "Have I done my part? Have I given to the best of my ability?"

THE FUTURE HOME OF THESE ENGINEERING ORGANIZATIONS

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A Special Message From the President

TO THE MEMBERS OF IES:

Council took an action of far-reaching importance this year —deciding that IES would associate with other major Engineering Societies in the new Engineering Center on the United Nations Plaza. The improved Headquarters operation, the enhancement of the Society's prestige and the benefits of occupying first-class offices in a mortgage-free building all will add considerably to the effectiveness of our program.

Along with the advantages, we have obligations—to share in the Center management—and right now to help push the fund-raising campaign over the top. As one of the new Administration's first tasks, I am asking each of our 10,000 members to share in the purchase of this future home for IES Headquarters.

If you have not responded to the appeal through the IES Fund-Raising Committee, use the form to contribute or subscribe your part toward our bogey of $75,000 out of the total $10,000,000 project.

Joe B. Bowder

PRESIDENT

Fill in and mail to:

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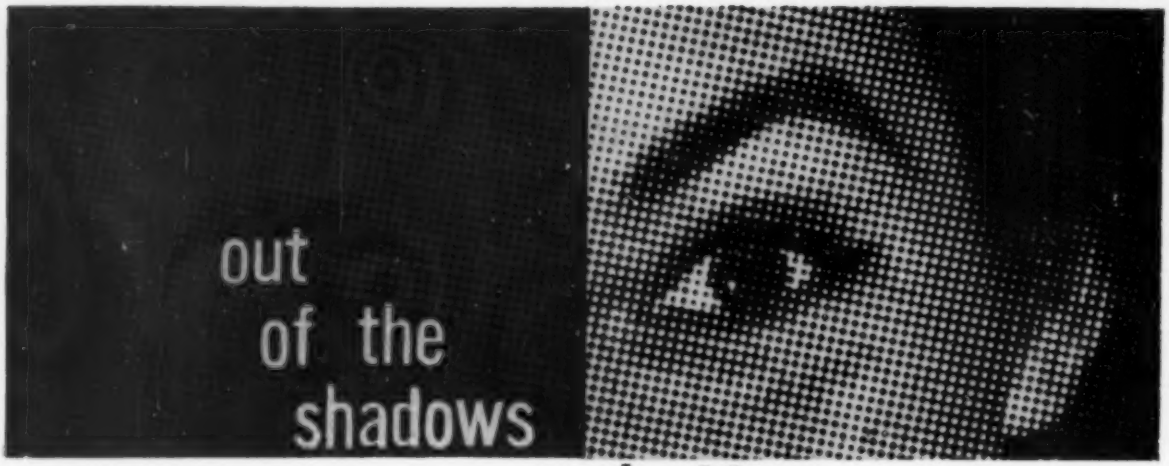

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ILLUMINATING ENGINEERING

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Engineered Lighting like this carries a Modest Price Tag — if it's

LITECONTROL

Visitors in the lobby . . . diners in the cafeteria . . . and personnel throughout the extensive general office area (not shown) at Peerless Mutual Casualty Insurance Company, Keene, New Hampshire, are seeing things differently these days. They are seeing things at their best with the aid of Litecontrol engineered lighting. It's versatile, functional lighting. It's lighting that diffuses the right intensity for every purpose and every area — without glare.

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FIXTURES
Lobby — Litecontrol luminous lens ceiling, using Holophane #6024 acrylic lenses; 40 watt rapid start lamps on 12" centers. Also two #3324-RS-PG fixtures.
Cafeteria — Litecontrol #3314-RS-PG, 1-lamp troffers with plastic grid louvers, 45° x 45° shielding. (Chandeliers by others.)
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Cafeteria — Average, 30 foot-candles in service (fluorescent only.)
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DESIGNERS, ENGINEERS AND MANUFACTURERS OF FLUORESCENT LIGHTING EQUIPMENT DISTRIBUTED ONLY THROUGH ACCREDITED WHOLESALERS

Unique combination of mercury, fluorescent and incandescent lighting systems has created in this elegant old (1906) bank, modern beauty and efficiency. The imaginative design of the lighting, at the same time retaining the architectural integrity of the splendid old building, won first prize in three separate IES contests for My Most Interesting Lighting Job.

FIRST PRIZE
CLASS II

milj

Crocker-Anglo National Bank

THIS INSTALLATION may represent the first time all three major light sources—mercury, fluorescent, incandescent—have been teamed for a bank lighting system. Interesting though this may be, however, the story of greatest interest to architects and lighting engineers lies in the artistic and engineering solution of a difficult and recurring problem in remodelling.

The problem is a familiar one. Preservation of architectural elements of grand and splendid character, while revising its interior to meet 1959 demands in lighting, pleasantness, and efficiency. Built to replace a previous structure destroyed in the San Francisco earthquake and fire in 1906, the bank has long been one of the city's most beautiful buildings, and a landmark of its downtown area. Typical characteristics are the classical Renaissance architectural forms, ornate ceilings, large windows.

The areas involved in the remodelling were office and administrative areas with ceiling height of 35 feet; working areas (clerical and teller cages) with 30-foot ceilings; general office areas with more

John C. Epperson Lloyd G. Dehrer
Golden Gate Section
South Pacific Coast Region

Mr. Epperson is National Sales Manager for Peerless Electric Co.; Mr. Dehrer, Chief Electrical Engineer with Buonaccorsi & Murray, Consulting Engineers, both of San Francisco, Calif.

All of the original architectural form has been preserved in the remodelled, relighted banking area. Note from the photograph above, the harmonious integration of good lighting (80 fc) and classical Renaissance architecture, with high skylight effects, column detail, great spaces. Skylight troffers in the 35-foot ceiling are six feet wide, using warm white fluorescent lamps and plastic low-brightness shielding. Mercury vapor sources (400-watt H33-1GL/X) have been used in the area shown below. They replace incandescent sources in the same locations, decreasing the watts per square foot used, increasing the lighting to 70 footcandles.

Contributing to the visual comfort, in addition to the quantity of light, are good brightness ratios within all fields of view. Walls are light cream color; windows are shielded, equipment is light colored. This area is lighted to 70 fc from mercury vapor recessed units.

normal 12- and 16-foot ceilings. A rather new approach to lighting was required for the combined circumstances of vast heights and spaces, the enhancement of these very characteristics, at the same time providing current levels of illumination.

One feature of the "before" situation was a central ceiling area which originally was a natural skylight. During the last war, this skylight was blacked out and artificial illumination provided, from fluorescent lamps with egg-crate louvering. At desk level, the illumination was 10 footcandles.

Solution

The original spaciousness afforded by the skylight has been retained in the new design. This features a fluorescent troffer six feet wide, in a rectangular pattern, having plastic low-brightness lenses. It is lamped with a total of 176 six-foot warm white fluorescent lamps. The troffer is coordinated with the existing architectural paneling of the ceiling. Fixtures are circuited to a panel in the attic area and contactor controlled from the first floor. Relamping is accomplished from the attic by means of detachable fixture tops. Uniform illumination, after 100 hours burning, is 80 footcandles; brightness measures 300 footlamberts, 60-degree angle.

In the teller and office areas, engineering plus design has achieved a *decrease* in watts per square foot used, with a four-fold *increase* (to 70 footcandles) in the illumination level. Further, no changes in capacity to branch circuit wiring and distribution system were required.

How come? Flush-mounted 400-watt mercury vapor prismatic reflectors with improved-color H33-1GL/X lamps were installed in the same locations as the original 500-watt incandescent downlights. No additional units. Metal louvers, developed in a square pattern, 1½ inches deep and painted a light cream color were provided with the reflectors for shielding the light source. Ballasts for the units are temperature rated at 105F. Temperature in the attic area was checked with a minimum-maximum type of thermometer which related to 84F minimum, 94F maximum.

To supplement the mercury vapor units for further color rendition, and for enhancing the classical architectural design of the ceilings, clusters of five R40 150-watt lamps were installed in existing column urns. Floor-mounted standards similarly lamped provide ceiling lighting in the east and west areas.

The lower-ceiling general office areas now have 80 footcandles with very comfortable visual conditions. This is from flush-mounted (in acoustical tile ceilings) six lamp fluorescent units, in 4- by 4-foot modules, with low-brightness plastic lens shields. Warm white lamps are used.

Overall effect of this lighting application is quite harmonious. On the practical side, it is also good economics. Relamping in the difficult high-bay area (by means of scaffolding) is now a three-year cycle as compared with a four-month period for incandescent. Power consumption per footcandle is considerably less than previously. Office tasks are now done in a lighting environment conducive to fast accurate seeing.

Architect for remodelling this bank was Milton T. Pflueger; consulting engineers were Buonaccorsi and Murray; contractor, Langlais Electric Co.; Fixture design by Peerless Electric, San Francisco.

Standard Equipment in

Esthetic

F. Brendan Burke

Western New York Section

Great Lakes Region

Mr. Burke is Vice-President, Engineering, of Ferguson Electric Construction Co., Buffalo, N. Y.

THIS IS A house full of light and children. Its design is traditional, in a built-up neighborhood, tailored to serve the collective needs of Mr. Burke, his wife and their seven children. Integral with the home is the lighting, designed by the owner. His aim: to light all rooms to IES standards as a minimum, to provide a flexibility of use and variety of feeling; all to achieve an interior different and unusual, yet practical for a family of

In the living room, cove and cornice strips on separate controls, and further controlled by dimmers, combine with a table lamp in the high ceiling room. The piano is spotted from a built-in accent light. With cove and cornice dimmed to half brightness, a dramatic as well as functional effect is achieved here.

Especially attractive is the dining room. Lighting here is entirely from incandescent sources. For the table, flush recessed annulites. For the window draperies and buffet, cornices using a mixture of ten-watt inside frost and R20 lamps on eight-inch centers. These are dimmed and separately controlled for different moods.

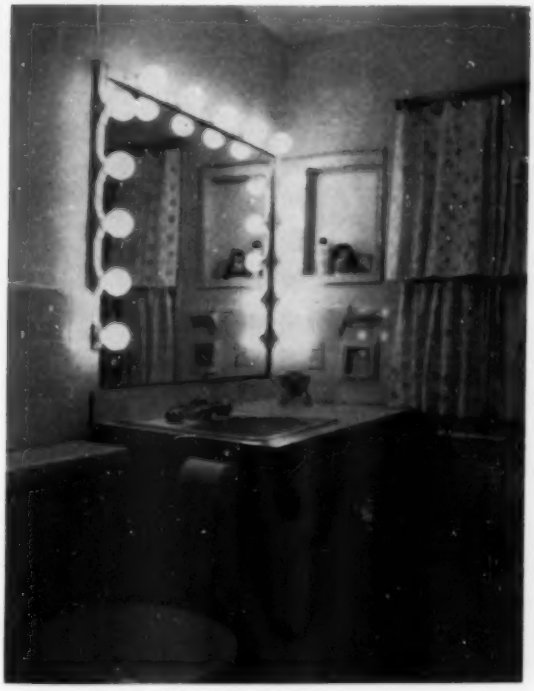
Combinations

seven young children. Standard, readily available equipments are used throughout. Colors of walls and carpets are designed to minimize contrast. Cornices, coves, valances, brackets, luminous ceilings, panels, accent lights have been decoratively combined for a practical but beautiful environment in the home. Only a few of the areas are shown here, but they serve to demonstrate the sensible yet subtle designs.

FIRST PRIZE
CLASS I

Still standard equipment but most unusual in result is the sloping luminous panel in the master bathroom. Two panels, two feet square, sloped and spaced below the ceiling, provide a solution to the mirror problem.

Family room — drama combined with function in the lighted desk alcove. General lighting in this area is from a fluorescent bracket with matching wood trim and decorative pull-down lamps.



Girls' bath has exciting theatre dressing-room atmosphere with 25-watt G40 lamps operated at 90 volts. In the boys' bath (not shown) commercial corridor units are employed around the mirror for functional bathroom lighting.

Master bedroom. Here a valance strip and dimmer continues for 20 feet along the window wall. There is also local lighting on each side of bed.

For the kitchen—a very high level of illumination. Fluorescent strips between ceiling joists are shielded by five 2-foot by 12-foot plastic sections supported by panel strips matching the kitchen cabinets. Light yellow is the motif, with pleasantly blending paper and wall tile. Note incandescent soffit over sink, concealed counter lights.

Rebirth of a Ballroom

SECOND PRIZE
CLASS II

Herman S. Williams

Ohio Valley Section

Great Lakes Region

Mr. Williams is a Consulting Engineer. George F. Schatz and Associates, Cincinnati, Ohio, were architects for the remodelled ballroom.

TRANSFORMATION of a sadly out-of-date ballroom, complete with artificial palm trees, festooned ceiling and an orchestra pit in the arms of a Sphinx to a plush modern hall, clearly cannot be accomplished by lighting alone. But the flexibility essential for an area which must serve such varied functions as a product exhibition, a fashion show and a ball *is* the achievement of lighting design.

The Cincinnati Music Hall Ballroom, home of the Cincinnati Symphony Orchestra, was built 80 years ago, prior even to the invention of the incandescent lamp. Many years of service notwithstanding, one look at the old hall (see cut, next page) and the need for a new face is obvious.

For the rejuvenation job, the ballroom (90 feet wide and half a city block long) was stripped to its bare walls and covered with a many-colored, flameproof cloth, specially designed and woven for the purpose. Repainting, refinishing of floors, new furniture, of course, were in order, but first came the lighting engineer with the assignment of providing illumination systems flexible enough to accommodate the widely divergent functions of the room

Before the remodelling began.

and economical enough to stay within the budget allocated by the City for remodelling. (The ballroom is municipally-owned.)

Most striking of the several lighting systems decorating the ballroom are two rows of "Cymbal" fixtures, designed by the lighting engineer and custom-built for the installation. These are perforated brass units with 100-watt uplights, 150-watt downlights and polished brass reflectors, similar in design to the musical instrument from which the unit takes its name. In keeping with the need for complete flexibility of all lighting elements in the ballroom, up and down lights in the units are separately controlled.

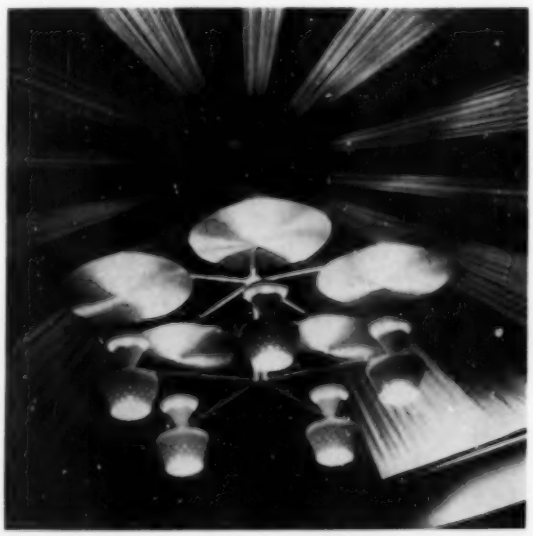
Perhaps some users of the ballroom might want the subdued atmosphere reminiscent of a cabaret. For this, the lighting can offer coves of colored fluorescent lamps along two sides of the room, in any of various dimmable levels. Hung along the sides for added decorative effect are polished sea shells mounted in leaded glass, each lighted by two 60-watt incandescent lamps.

Guests at a dance might enjoy the atmosphere of a low level of light, but for the musicians at work a comfortable high level of illumination is essential. Mounted over the bandstand are 300-watt R40 floodlamps in baffled downlights which provide adequate illumination for the orchestra even when the rest of the ballroom is in semi-darkness. Musicians who have performed here say the lighting is superb.

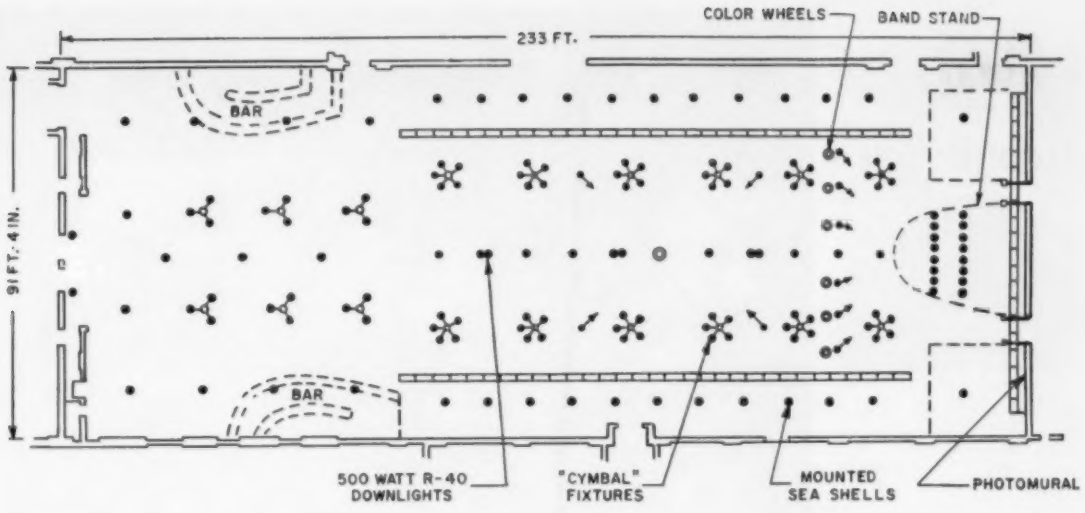
A fashion show could be held in the Music Hall Ballroom or a television program produced from this beautiful setting. For such eventualities, there is a row of well-shielded downlights with 500-watt PAR64 floods, producing a brilliant path of light down the center of the hall.

Special effects for floor shows or other theatrical presentations are available with the use of any or all of six color wheels (five colors in each wheel) installed across the front of the room. Each of the color wheels can be operated individually, by remote control.

Pièce de resistance of the transformed ballroom and pride of its architects is a 20-by-80-foot color



"Cymbal" fixture, designed by the lighting engineer and custom-built for the Ballroom, is a perforated brass unit with 100-watt uplights, 150-watt downlights and polished brass reflectors. For flexibility, up- and downlights are separately controlled.

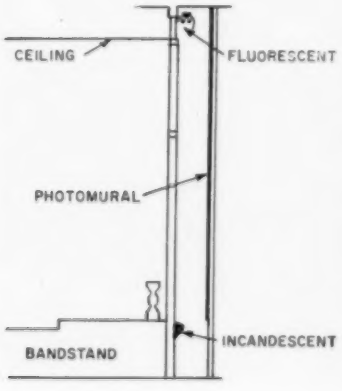


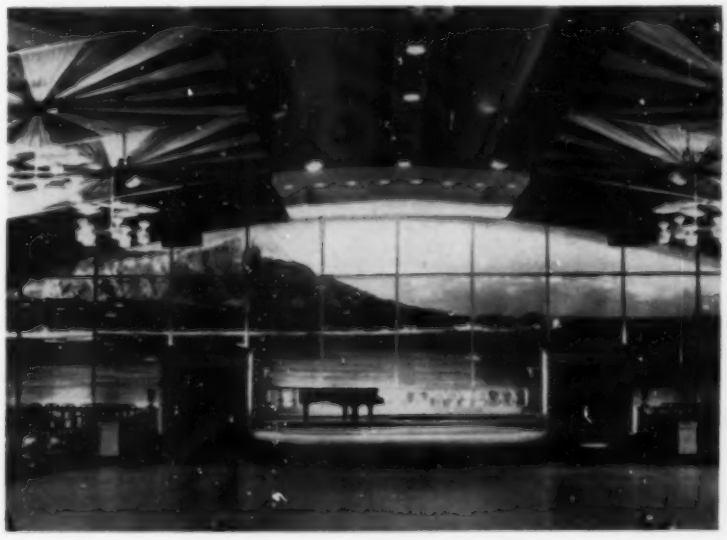
Floor plan.

photomural, the largest in the world. (The mural was so large it had to be processed in an airplane hangar.) When the drapes behind the bandstand are drawn back they reveal a scene which no picture window in downtown Cincinnati (or many other places, for that matter) could equal—a panoramic view of Diamond Head, Hawaii. Adding to the splendor of the mural is its lighting—fluorescent at the top; incandescent from the bottom (see drawing).

Behind the scenes operation of the complex lighting systems available in the ballroom is from a specially designed control board with 150 points of control. From this board, located behind a one-way, half-silvered mirror at the rear of the room, lighting levels can be varied from a minimum of a few footcandles to over 75 footcandles. A TV show has been televised from this "studio" with no additional lighting except for a few portable floodlamps to soften facial shadows. Whatever the function—banquet or business show—the flexibility of its versatile lighting design makes the Cincinnati Ballroom one of the best equipped and most sought—anywhere.

Color photomural of Diamond Head, Hawaii, is lighted by fluorescent from top, incandescent from bottom.





milj

SECOND PRIZE

CLASS I

"All we need's a fixture"

—*The Education*

THIS STORY began with an electrical contractor who asked a lighting consultant for advice on "what fixture to install in this cellar" to complete his work in a newly remodelled basement. It ended with a family pleased with the comfort and versatility of their new recreation room. In between, however, came the lighting designer with knowledge of the functional and decorative value of engineered illumination, and the lighting plan he devised for this room may well serve as a guide and inspiration to others who are owners of "finished" basements

The success of this installation may be attributed to the application of several basic principles of illuminating engineering, resulting in a balance of general and accent lighting with good brightness ratios in a lighting plan keyed to the architectural design and varied functions of the room. For example (see cuts):

Over the sofa, installed 18 inches from the wall are baffled downlights equipped with 75-watt PAR-38 floods, providing 17 footcandles of general illumination. Serving a dual function, this lighting

of a Contractor

has the decorative value of increasing the apparent texture of the pecky cypress walls which, incidentally, were rubbed with white to increase their reflection factor.

Highlighting the cocktail tables in front of the sofa are 75-watt R30 spots focused directly over the tables, *and* the light reflected back to the ceiling by the white table tops has the added benefit of reducing the contrast between sources and surround. An angled spot with 75-watt R30 floodlamp puts 18 vertical footcandles on an important accessory in the room — the painting of the clown. Portable lamp to the right of the sofa, chosen by the owners for its decorative value in the room, contributes to the balance of the lighting by adding an upward component to the illumination design.

At the other end of the sofa, used solely for decorative accent, is a suspended downlight lamped with a 25-watt flame tint incandescent. In keeping with its decorative purpose, this unit is on separate control. All lighting over the sofa is controlled by dimmers for varying effects.

The white-topped console unit in the center of the room, housing the television set and often used for buffet service, was used by Mr. Shemitz for brightness balance—to reflect light from two 75-watt PAR38 floods (see both photos). Specific function of the lighting here was to provide a comfortable environment for TV viewing.

Sylvan R. Shemitz

Connecticut Section

Northeastern Region

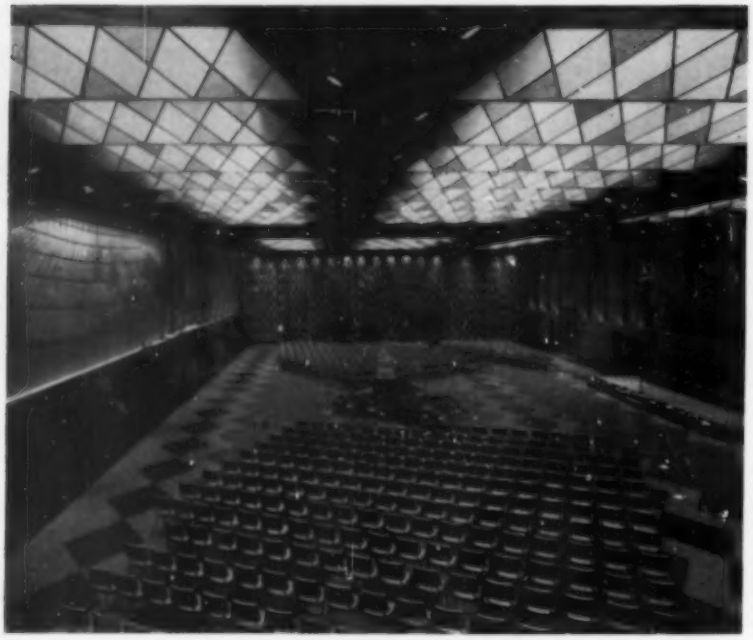
Mr. Shemitz is President of C. S. Mersick Electric Supply Corp., West Haven, Conn. Electric Contractor was Jacobson Electric.

Bar area, enhanced by both decorative and utilitarian illumination, from every conceivable angle, is ready for all patrons. Three dimmer-controlled downlights (75-watt R30 floods) are recessed overhead; continuous fluorescent strip is installed behind for the comfort of the bartender; continuous lumiline lamps *underneath* serve to enhance the grain of the wood. Four eye-ball units with 60-watt incandescent lamps angle light back to the wall to display the harlequin wallpaper.

For the player piano to the right of the bar, there are 20 footcandles of illumination from a 150-watt R40 flood in an eye-ball unit.

Conversation piece and special feature of the lighting for this recreation room is the illusion of daylight behind the louvered doors to the right of the piano. These doors lead, not to a beautiful garden, but to a prosaic, ugly boiler room—the necessary component of any basement. However, three F40 T12 daylight fluorescent lamps in open strips have been installed around the door, creating the pleasant sensation of perpetual daylight beyond. Flat white paint on the boiler room side of the doors reflects a maximum amount of "daylight" through the louvers and into the room.

Three dimmers (two with 800-watt capacity, one with 450-watt capacity), 14 switches plus a master contactor to turn all lights on and off give the room complete flexibility for every kind of function—teen-age dancing party, sophisticated cocktail party or family relaxation after a long day.



Canadian Room as seen from the balcony, showing draped fabric over end wall, global relief map at left and Canadian Coat-of-Arms at right.

Two Beautiful Rooms at

Toronto's Royal

RECENTLY a new extension was added to the grand old Royal York Hotel in Toronto, Ont., for conventions, exhibitions, concerts and other public events. Two of these public rooms are featured in this prize-winning My Most Interesting Lighting Job contest entry by lighting designer Rollo Gillespie Williams, lighting consultant for the architects.*

Rollo Gillespie Williams
New York Section
Northeastern Region

Mr. Williams is Director of Color Research and Lighting Consultant with Century Lighting, Inc., New York, N. Y.

Largest of the two rooms is the Canadian Room —above—a huge area, 180 feet long, 80 feet wide and 28 feet high, with a spacious balcony. The variety of functions for which this room is used, that is, exhibitions, dances, TV presentations, banquets, etc., requires that its lighting be extraordinarily adaptable, not only in spectral quality and footcandle levels, but in the sense of producing changes in the decor to harmonize with different events. Thus, the lighting had to be designed as an integral part of the decor. Further, it was decided that the public rooms of the new wing should feature Canadian materials and motifs, and this policy is keynoted in the Canadian Room where the lighting was also required to display the wood

*Ross, Fish, Duchenes and Barrett of Montreal, Que., were the architects, Ernest G. H. Rex, I.D.S., A.I.D., of that company, was responsible for interior decoration and design. Engineers: James Keith & Partners. Photographs: Neil Newton Studios.

Ontario Room, Royal York Hotel. Decorative lighting fixture here is shaped in the form of a basket of trilliums, Ontario's floral emblem.

York Hotel

THIRD PRIZE
CLASS II

panellings and carefully chosen materials without color distortion.

One of the most striking features of the room is the ceiling. This is, at once, an intricate lighting device capable of numerous effects and a colorful element of the decor. The higher ceiling level comprises angled surfaces made up of triangular and diamond-shaped honeycombed panels in gold, blue and silver. Openings in these anodized aluminum panels are about one-quarter-inch in diameter. A total of 1740 warm white 40-watt fluorescent lamps with dimming ballasts are positioned behind these panels to illuminate them evenly, with comfortably low surface brightness. Side and center panels may be dimmed separately. The lower ceiling level uses angled plaster surfaces with incandescent reflector downlights, providing full floor coverage. Two hundred-watt GS lamps are used in the long runs; 300-watt GS lamps in the cross runs. In the drawing, Fig. 1, a part longitudinal section shows the technique of this design.

Half cross section drawing, Fig. 2, shows how the higher ceiling level carries 16 rows each of fifteen 40-watt fluorescent lamps over each of the four side panels, and 26 rows each of fifteen 40-watt lamps over each of the two center panels. The downlights in the lower ceiling level are mounted at right angles to the floor. The dropped ceiling

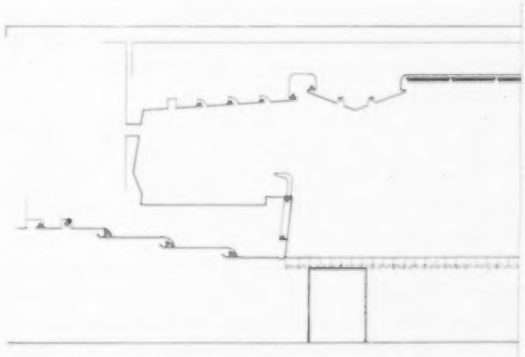


Figure 1. Part longitudinal section of the Canadian Room, Royal York Hotel, showing lighting of areas over and under the balcony.

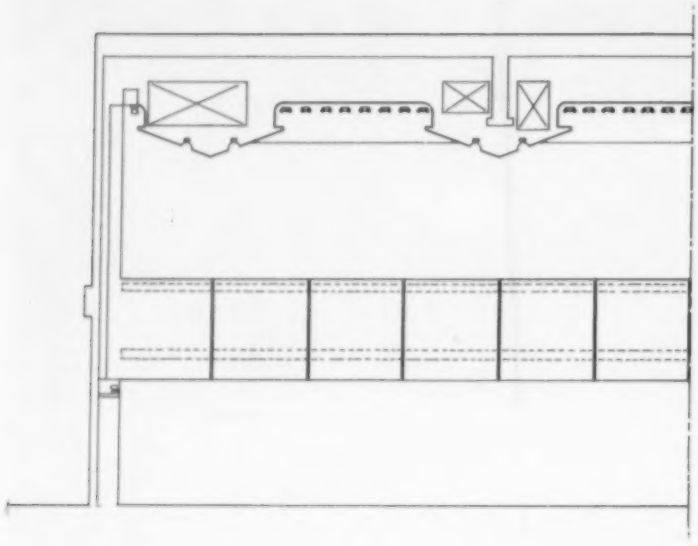


Figure 2. Half cross section of Canadian Room showing higher ceiling level for fluorescent lighting and lower level for incandescent downlights.

creates a lighting cove along each side wall, for the wall panels.

Areas over and under the balcony are illuminated by cold cathode tubing concealed in coves and controlled by dimmers.

An important feature of the ceiling downlighting is that the units contribute to the color of the decor without affecting the functional quality of the lighting. This arrangement is shown in Fig. 3. The specular reflector directs the main downlighting through the ceiling aperture as shown. However, direct light from the lamp also illuminates the colored louver assembly which is imaged by reflection in the reflector surface. Thus, at normal viewing angles the reflector appears to be colored, while the louvers themselves are viewed in color. While the downlighting is actually white, each unit appears as a colored accent point in the ceiling. Ninety-four such units give a gold effect and 98 units a green effect, harmonizing with adjacent colored ceiling panels. The louver assembly is detachable and may be replaced by one of any other color desired.

Much of the wall surfacing is of stained poplar wood panelling. This is lighted from the top by 75-watt PAR38 lamps on 12-inch centers, concealed behind small mesh grilles, and from the bottom by similar lamps, in a trough.

A 47-foot wide global projection relief mural map of Canada dominates one wall (at left in photograph). In addition to 75-watt PAR38 lamps on 12-inch centers top and bottom, the face of the map is also lighted by twelve 150-watt angled reflector lamp downlights.

On the opposite wall is a silhouetted Canadian Coat-of-Arms in full relief. The dais area below this is provided with additional illumination from twelve 400-watt optical downlights with adjustable masking shutters. The draped fabric at the end is lighted by concealed downlights with 200-watt lamps. Not shown in the photograph, but an exceptionally effective decorative feature, is the balcony front, which has 12 painted glass panels backlighted with cold cathode tubing.

The various groups of lights are on separate dimmers and may be varied independently of each other. Lighting arrangements will provide 65 footcandles of general illumination from the ceiling equipment—40 fc fluorescent and 25 fc incandescent lighting. The proportions and over-all intensities can be varied and full floor coverage obtained

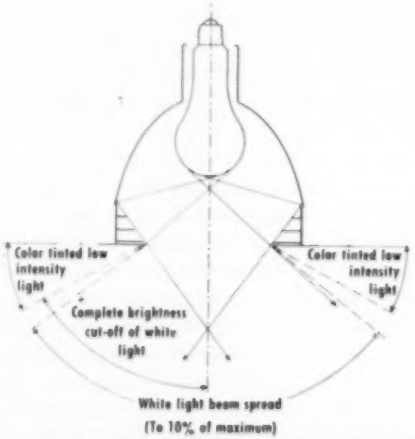

Color tinted low intensity light
Color tinted low intensity light
Complete brightness cut-off of white light
White light beam spread
(To 10% of maximum)

Figure 3. Sectional view of the special (now standard) incandescent downlight used in the ceilings of both the Canadian and Ontario Rooms.

Figure 4. Banquet in Canadian Room in honor of Queen Elizabeth II of Great Britain.

by either type of lighting, alone. At all times—and this is very important—the color rendition of the wood panelling, carvings and special draperies remains constant.

An impressive effect of the lighting is the change that variations of intensity alone can create in the over-all appearance of the room. At higher lighting levels, the gold, blue and silver ceiling panels are nicely balanced as bright gold, bright turquoise blue, and silver. Lower levels cause marked changes in the color and balance of the panels. The gold appears relatively brighter, and the blue much deeper, compared to the silver, which remains unchanged as a comparison color. When the lighting level is quite low, the colors become antique gold and deep Mediterranean blue, while the silver turns to white. These color changes alter the emphasis on diamond or triangular shaped panels. When the fluorescent panel lighting is out in the lighted room, the aluminum panels look like stained glass.

Changes of intensity also vary the appearance of the incandescent ceiling downlights. In these, the gold units appear first yellow and then orange, as the lighting is reduced, while the green units shift toward amber. These changes completely alter the appearance of the ceiling and its contribution to the over-all effect of the decor.

The appearance of other features can also be varied by the lighting level provided. For example, the face of the global relief map changes as its front lighting is dimmed. By contrast with the gold background, the blue areas of ocean become deeper, while gold land areas become more orange. Lettering fades out and the map appears in greater silhouette against the background.

Combinations of adjusted lighting levels for different areas provide a wide range of environmental effects, which are achieved in a simple and economical manner.

Fig. 4 shows a banquet in the Canadian Room attended by Her Majesty, Elizabeth II, Queen of England, during her 1959 visit to Canada. The top table is highlighted by the twelve 400-watt optical spotlights already mentioned.

Ontario Room

A number of public areas open off the Canadian Room and one worthy of particular mention is the Ontario Room. This is essentially a dining room measuring 70 feet by 60 feet. The suspended ceiling includes four domes edge-lighted with cold cathode tubing. From the center of each of these is suspended a decorative lighting fixture shaped in the form of a basket of trilliums (Ontario's floral emblem), using incandescent lamps for decorative purposes only. Cool white fluorescent lighting is concealed in the broad cove around the ceiling perimeter to illuminate specially shaded blue draperies, which are also lighted by cool white fluorescent at the bottom. Much experimentation was required before the final effect of graded coloring was achieved. Wall lighting contrast is provided by incandescent lights on the pilasters between the sections of drapery. The over-all spectral quality of the room lighting is assisted by 49 incandescent reflector downlights in the suspended ceiling, arranged in a special pattern. These are provided with alternate green and gold interior couplers to make them blend with the decor. Lighting levels are completely dimmer controlled.

The beauty of these two rooms is truly the result of "from-the-start" collaboration of architect, interior designer and lighting consultant. Only color pictures—or better yet, a personal visit—can adequately project their visual effects. The bare bones of a technical description must fail to convey the unique variations in color and atmosphere and could never do justice to the lighting effects in their numerous subtle variations.

Floodlighted doorway and side lanterns welcome the visitor to

Sara's Laboratory

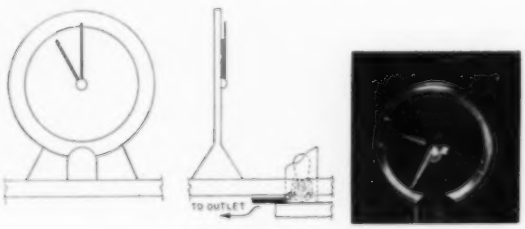
THIRD PRIZE
CLASS I

Entertaining is the chief function of the living room. Four 40-watt fluorescent lamps are used in the 18-foot valance; light-colored draperies reflect light back into the room. Throughout the house, lamps are deluxe warm white.

Another built-in feature (above) is the hi-fi-television center. Similar arrangement (20-watt T12 concealed) supplies 75 fc on the record player.

Do-it-yourself built-in lighting provides 80 fc on this desk in the family room. One 20-watt T12 lamp is concealed behind a three-inch overhang from bookshelf.

Note the illuminated clock over the hi-fi center. A close-up and drawing (below) reveals a clever technique for this interesting item. A 686 range-oven lamp is concealed behind a shelf of burnished copper, which is painted white inside. Mounting is in a porcelain socket, on a wood block inside the cabinet, with an opening in the cabinet top.



RESIDENTIAL lighting specialist Sara Perkins has used her own home as a "laboratory," a proving-ground, that is, for practicing what she preaches, and demonstrating what she teaches. Since her income bracket is within the great majority, her lighting also demonstrates the achievement of current recommended practices and light for decoration, on a budget.

Lighting plans were laid out carefully, integrated specifically with *this* house, and with the several personally interesting items within it. An interesting example of this: a silver tray in the dining room, especially personal since it was an award to her husband from his Masonic Lodge. A frame supporting the tray conceals two 40-watt T10 lamps to highlight its place of honor.

Details of the methods and effects may be seen from the accompanying pictures of a few of the areas within the house.

Dining room wall to wall valance uses three 40-watt T12 lamps. Ceiling fixture is 36 inches in diameter, lamped with 31 7C7 lamps.

Sara Perkins
Georgia Section
Southeastern Region

Mrs. Perkins is a Home Economist with the Georgia Power Co., Atlanta, Ga.

Balanced levels of 40 fc in the kitchen (above, right)—from a five-foot open soffit over the sink (two 40T12), continuous under-cabinet lightings, and white counter tops. Center fixture uses one 150-watt incandescent lamp.

Built-in luminaire over the dressing table at right uses two 40-watt fluorescent lamps and provides 40 fc on the vertical surfaces of the face.

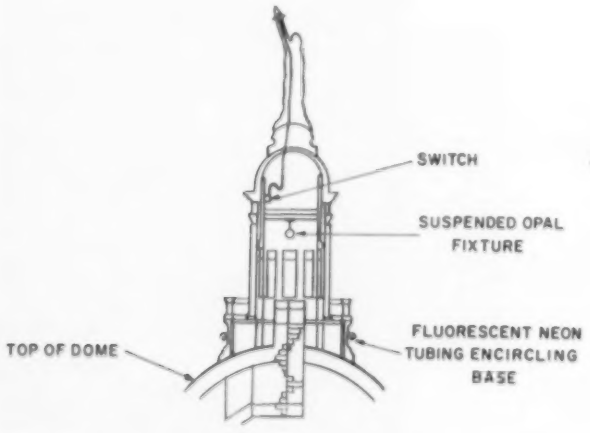
Floodlighting the Gold Leaf Dome of

ATLANTA'S sunny skies provide ample sparkle to its Capitol Dome. In the daytime, that is. At night this landmark loomed only as a dark shadow against the skyline. The installation which was the year's most interesting job for L. Ralph Bush has changed all that.

Georgia's State Capitol Building, built in 1884, was completely renovated in a State project which included a new electrical design inside and out, repaired and recovered main dome, gold leaf applied to both this dome and the smaller dome of the cupola. The gold was donated by citizens of Dahlonega, Georgia, and the entire project was a source of pride and interest to all Georgians. Although Mr. Bush's lighting plans included the whole building, the design which challenged him most was the nighttime floodlighting of these golden domes, and of the Statue of Freedom which stands from the top of the Capitol.

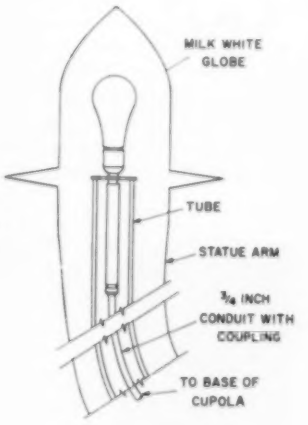
Maximum contrast, to highlight these elements, was, of course, his chief aim. New F-400-watt colortone deluxe warm mercury lamps were chosen, after a series of tests, to floodlight the lower or main section of the building. Two fixtures for the main entrance use the F-1000-watt size in this color characteristic. All lamps operate from high power factor ballast on 460 volts. Incandescent lamps are used in floodlighting the vertical section under the dome, the dome, cupola and statue. This provides interesting color contrast between the facade and dome section.

Dimensions involved in the job are: from ground to the top of the statue, 237 feet; roof to top of statue, 170 feet. The statue itself is 21 feet tall.

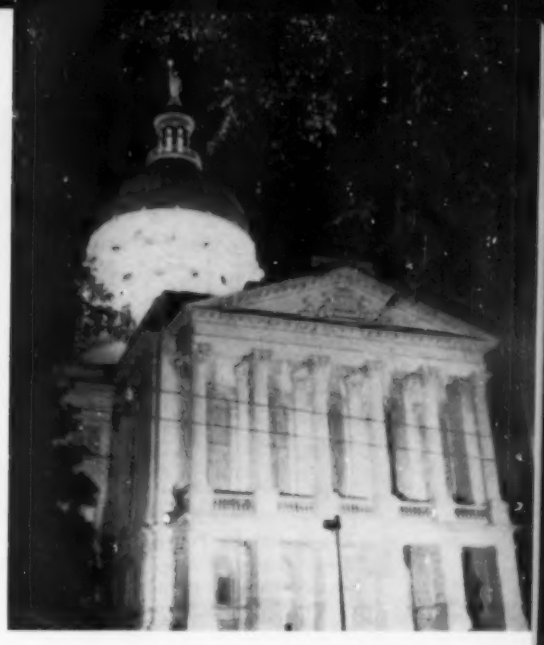


◄ Drawing 1

Drawing 2 ►



Georgia State Capitol



Floodlights around the roof are 500-watt PAR64, narrow, medium and wide beam lamps positioned to light the vertical section and dome uniformly. In order to make the gold appear more natural, all floodlights focused on the dome have medium straw color lens. Eight narrow beam spots, two to the side, using 500-watt lamps, are used to light the cupola and statue. Lights shown in the round center area are downlights installed flush in the balcony ceiling, to illuminate the inside walkway around the base of the vertical section.

Drawing No. 1 shows a section through the vertical dome base, dome, cupola, statue and arm. To light the interior of the cupola, four molded plastic enclosed fixtures are installed on equal spacing around the wall, each with two T12 40-watt rapid start lamps and a 200-watt opal sphere suspended from ceiling of cupola.

Lighting the Statue of Freedom was almost a separate "most interesting job" in itself. She holds a torch in her right hand and a sword in the left. To provide a spectacular flame for her torch, the right arm was removed, the torch rebuilt of white molded plastic to resemble a flame, and then reinstalled, with ventilation to prevent overheating. Within the torch is installed a flame type special service long life incandescent lamp operating under voltage to give a flame color to the torch.

Relamping this was also an interesting job. Mr. Bush designed a metal tube for this problem, large enough for the lamp and socket to pass through and extend from the base of the torch, down inside the arm, and down inside the statue body to the space under the cupola dome. This tube is not straight but is curved at the elbow, and where the arm joins the body. Drawing No. 2 shows close-up detail. The lamp socket is on the end of a three-quarter-inch conduit which is in sections with ball and socket type of couplings, so that it can bend and pass around the angle in the arm and body and can be uncoupled as the lamp and socket are lowered for relamping. With a new lamp in place, it is then easily returned to its place in the torch and locked in position.

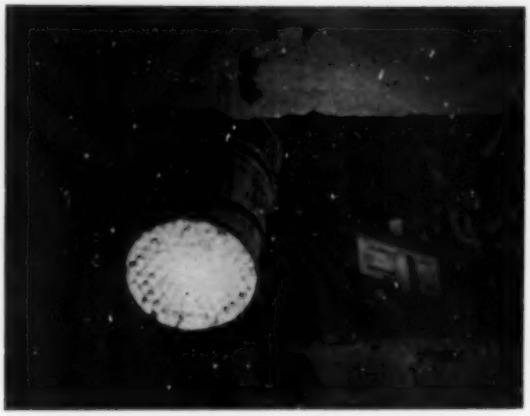
The final view presents a brightly lighted main entrance with subdued lighting on the wings, striking color contrast between the main building and the floodlighted dome, and a statue holding aloft its flaming torch.

FOURTH PRIZE
CLASS II

L. Ralph Bush
Georgia Section
Southeastern Region

Mr. Bush is with Bush-May & Associates, Atlanta, Ga.

1. The Materials. Top left, porcelain sign socket with 7-watt lamp; bottom, R12 aviation reflector lamp; transformer, aluminum louver, beer can housing.



2. The Method. Beer can housing secured to ceiling joist with slightly sprung plumber's tape makes fixture over table. Note transformer at right.

Interesting Light Sources

HOME-MADE lighting units, an unusual application of miniature specialty lamps and the ingenuity of a lighting engineer were combined in the relighting of this dining room to produce a prize-winning installation. Goal in the relighting was to create an atmosphere conducive to leisurely dining—control of lighting components to provide even general illumination punctuated by dramatic emphasis on important elements in the room.

Desire for warm color rendition and quiet operation of lighting system dictated the use of incandescent sources; the use of low voltage lamps seemed particularly adaptable to the area. With no low voltage fixtures available commercially, one had to be designed on the job—at minimum cost. Solution to this proved to be lamp housings made from beer cans fitted with single contact bayonet sockets and powered by radio filament transformers recessed above the ceiling. One "beer can luminaire" equipped with a six-volt automotive lamp and louvered with hexagonal cell pattern aluminum panel was recessed above the sideboard for dramatic accent. The lamp was sprayed with window frosting to soften the light distribution. Decorative finish is a framed piece of gold byzantine plastic mounted on the ceiling below. Excellent localized illumination for buffet service is obtained with this technique.

Over the dining room table is another home-made unit, this one equipped with a 12-volt aviation reflector lamp. Slightly sprung plumber's tape secures the fixture to a ceiling joist, making, in effect, an adjustable unit. Completing this fixture is a two-foot square, gold, baroque architectural panel, moulded in deep relief, framed and mounted below the unit. Added color effect is gained from the "gold" lining of the beer cans which accentuates the warm spectral distribution from the incandescent sources, enhancing the appearance of both food and complexions.

Lighting for the large painting on one of the dining room walls was also accomplished with the use of miniature lamps. Here, three pairs of three-volt flashlight lamps are recessed in tandem within the picture frame, producing a soft and subtle "invisible" illumination. This has the effect of adding

R. L. Sawyier
Golden Gate Section
South Pacific Coast Region

Mr. Sawyier is Chief Illuminating Engineer with Pacific Gas & Electric Co., San Francisco, Calif.

3. The Results. Top left, moulded panel covering beer can shown in photo at left; top right, accent lighting over sideboard. Note also valance lighting for general illumination.

FOURTH PRIZE
CLASS I

For Dramatic Dining

an apparent third dimension to the painting.

Two small radio filament transformers recessed above the ceiling provide the power for the low voltage units—a 1.2-ampere, 3-volt transformer for the flashlight lamps and a 6-ampere, 12-volt with centertap for the "beer can" units.

General illumination for the dining room is from a valance constructed on two adjacent walls. Porcelain candelabra sign sockets on eight-inch centers are mounted and wired to a portable light strip behind a ten-inch drape covered board. White frosted seven-watt night lights installed in these housings give feather edge diffusion on the ceiling. Lamps directly over the picture window areas can be turned off to eliminate annoying veiling glare—so difficult to control with long linear sources. Accent and general lighting are dimmer controlled and separately switched for complete flexibility, giving the owners the choice of a wide range of dining atmospheres.

Looking up into valance strip. Porcelain sign sockets on eight-inch centers with seven-watt night lights.

Three pairs of three-volt flashlight lamps recessed in tandem in picture frame to light the painting.

Measuring F-Lamp Characteristics For the Outdoor Environment

By P. R. HERRICK
R. E. WENNER

The designer must know the effect of temperature and wind on the performance of a fluorscent-lamp luminaire in order to predict the illumination it will deliver under outdoor conditions. An environmental test chamber for such measurements is described. Proper evaluation of test results in the environmental chamber is outlined by reference to Weather Bureau data. A simple step-by-step procedure—not requiring an environmental chamber—is presented for estimating performance of a fluorescent-lamp luminaire over a range of outdoor conditions.

PREDICTION of illumination from fluorescent lighting systems under outdoor conditions contains an element of uncertainty because temperature and wind have a major effect on light output of the lamps. Measurements of this effect may be made in an environmental test chamber spanning the range of conditions that exist outdoors.

Environment Test Facility

Fig. 1 shows a sketch of an environmental test chamber constructed for application engineering studies of fluorescent lamps, bare and in luminaires. The chamber consists of a 10- by 10- by 10-foot room controllable in temperatures from —40F to 100F, and in humidity from 10 to 90 per cent. The room is constructed with a false ceiling and false rear wall. Air is drawn through an opening low in the false rear wall, through cooling coils and heater A), and exhausted by a centrifugal blower (B) into the cavity above the false ceiling. This ceiling is made of perforated metal. The conditioned air enters the room through these perforations.

With this construction, good temperature control is obtained with a minimum of air movement within the chamber. Less that 50 feet per minute movement is obtained throughout the room, except within a foot or so of the opening at (A). From the view-point of the weatherman, this is a dead calm. It is too slow to be felt by the skin. It is similar to the average air movement in an air-conditioned building. However, it is more air movement than that generally permitted in a photometric laboratory. With most outdoor-type luminaires, the slightly greater air movement in the environmental test chamber appears to have little effect, but with bare lamps and some open-top-and-bottom luminaires, occasional discrepancies do appear between photometric readings and environmental test readings at 77F. The problem is that close temperature control cannot be obtained with still air.

An additional apparatus is a portable 2- by 2- by 8-foot wind tunnel which may be operated either inside or outside of the test chamber. Wind velocity from 3 to 25 miles per hour may be obtained. This has proven to be one of the most enlightening features of the test facility.

This tunnel is limited, with respect to wind direction, by its dimensions. If a test luminaire is longer than two feet, wind may be directed only parallel to the axis of the lamps and luminaire, or a few degrees from parallel. Investigations with a

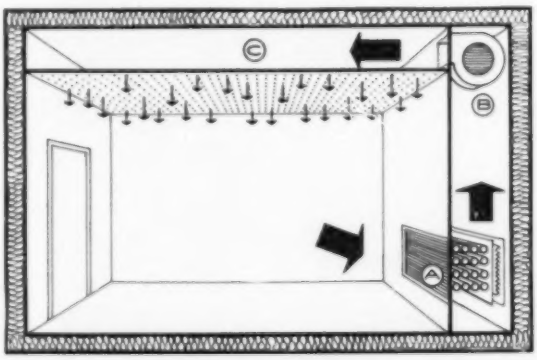


Figure 1. Cutaway elevation of environmental test chamber. Air is drawn through cooling coils and heaters at "A", exhausted into the cavity above the false ceiling by blower "B" and enters the chamber through the perforated ceiling "C".

A paper presented at the National Technical Conference of the Illuminating Engineering Society, September 7-11, 1959, San Francisco, Calif. Authors: General Electric Co., Large Lamp Dept., Cleveland, Ohio. Accepted by the Papers Committee as a Transaction of the I.E.S.

two-foot luminaire indicated that lamp temperatures may be five to ten degrees cooler under some conditions when the wind is perpendicular than when it is exactly parallel. However, it appears that at small angles from parallel, conditions nearly as severe as perpendicular can be produced.

A combination of a programmer and two or more recorders permits unattended overnight operation of the facilities. The programmer consists of several cams driven by synchronous motors. A temperature-control cam is cut to a shape conforming to a pre-determined schedule of temperature steps. This cam controls a pneumatic system which actuates heating and cooling coils in response to a fluid temperature-sensing element within the chamber. Electrical-control cams superimpose refinements and adjustment of operation of the heating and cooling coils to minimize temperature deviation or "hunting." Timing cams provide additional flexibility in a test-time table; they may be set to stop the motors of the temperature-control and electrical-control cams whenever extra time is needed at any particular temperature.

One recorder, which is part of the pneumatic temperature control, records temperatures on a circular chart during a test. The second recorder provides a continuous strip-chart record of light from a test luminaire throughout a test. A paddle of four-color-corrected selenium cells is connected across a 100-ohm helical potentiometer and the recorder actuated from the brush, to give a variable range. Additional recorders may be used for continuous records of bulb wall temperature and electrical characteristics of the test lamp, if desired.

Recorders are of particular value since they not only permit unattended operation but also provide a more complete record of performance variation than that obtained by individual readings. In the event that a peak in characteristics occurs between temperature settings, the recorder will show the value. Any lack of lamp stability, power interruption, or malfunctioning of the equipment will also be indicated.

Environmental Testing Procedure

This facility has been in operation for over two years. During this time a testing procedure has evolved which combines efficiency of operation with good accuracy. A typical test on an outdoor luminaire proceeds as follows:

(1) The test luminaire is hung in its normal operating position approximately in the center of the chamber and is turned on.

(2) The paddle of four light cells is located within a smooth high portion of the light distribution from the unit at a distance of about four feet.

(3) The programmer and recorders are turned on and checked for proper operation.

(4) The programmer brings the chamber temperature to 100 degrees and holds it there for about six hours. Data are recorded on the charts throughout this and succeeding steps.

(5) The programmer brings the chamber temperature to 77 degrees, then to 60 and in 20 degree steps to — 20 degrees. Two to three hours are allowed at each temperature step.

(6) The chamber temperature is raised to a reasonable working level. The test luminaire is placed in the wind tunnel and is turned on.

(7) The paddle of light cells is placed inside the wind tunnel and is located to measure light reflected from one side of the tunnel.

(9) The programmer and recorders are put into operation over the same temperature and time schedule as before.

(10) If the test involves a second wind velocity, the fan is readjusted and the temperature steps are repeated, often in the reverse order to conserve testing time.

Certain parts of this testing procedure warrant further comment. One such comment is that the above test time-table, in most tests, includes adequate allowance for lamp stabilization initially and at each step. That is, the initial six-hour period at 100 degrees is usually long enough to allow all the liquid mercury to collect at the coolest point. This relatively short time suffices because the high temperature speeds mercury migration. After all the liquid mercury has thus been collected at the coolest point, stabilization is usually reached within two to three hours following each temperature reduction of 20 degrees. In general, a two-hour interval is allowed for the higher temperatures, and three hours for the lower temperatures. At each temperature level, the chart of light output tells whether stability has been reached.

Another comment is that the output of a selenium cell may be affected by temperature change. This may be checked by means of an adjacent filament lamp and an adjustment made if needed. With the paddle of four cells, connected across the 100-ohm potentiometer, and illumination levels of 50 foot-candles or more, the effect of temperature on the cells has been found to be negligible.

Still another comment relates to the extent of value of measurements of electrical characteristics and bulb wall temperature, in addition to light output. For application purposes, light output is of primary interest, and it is the most sensitive to changes in ambient temperature. Hence the principal value of supplementary measurements of electrical characteristics or bulb wall temperature

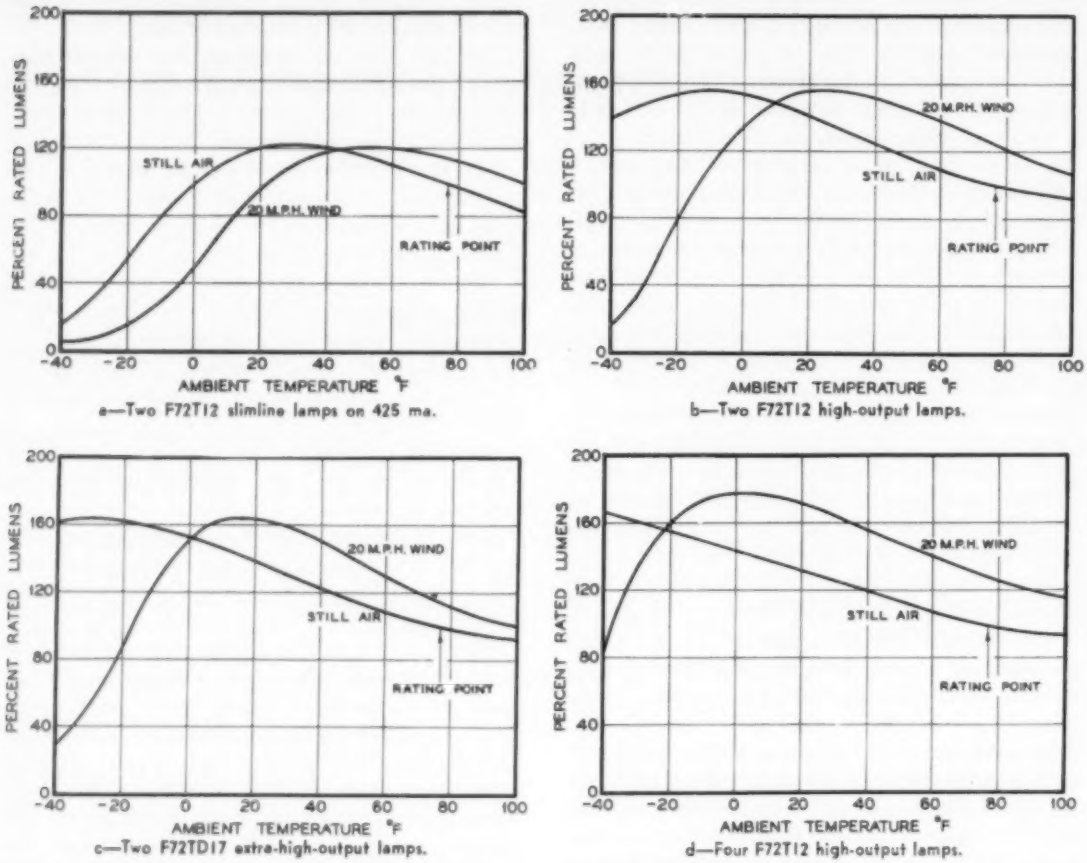


Figure 2. Temperature characteristics of the same fluorescent floodlight with three different lamp types. Each curve is drawn relative to the photometric rating with the particular lamps. That is, for each lamp combination the light output at 77 degrees, still air, is taken as 100 per cent.

is as a standby in the event of accident to the charting of light output.

Presentation of Environment Test Results

The results of environmental tests may be most easily grasped and applied when presented graphically as in Fig. 2. This is the form of charting used by most other investigators. It will be noted that the "Rating Point"—plotted as a light output of 100 per cent—applies to an ambient temperature of 77 F and "still air," the conditions under which luminaires are photo-metered. As previously stated, "still air" in environmental testing is minimum air movement within the test chamber consistent with temperature control. All other points are plotted relative to this rating point. This method has the advantage that performance of a luminaire under a given set of weather conditions can be determined by multiplying its photometric data—candlepower, lumens, efficiency, etc.—by the appropriate percentage from the temperature curve.

Fig. 2 shows the characteristics of one type of floodlight equipped with four lamp combinations—two slimline lamps at 425 ma., two high-output lamps at 800 ma., two extra-high-output lamps at 1.5 amperes, and four high-output lamps at 800 ma It will be noted that the resulting temperature characteristics are quite different, due to variation in lamp watts and in total wattage within the luminaire. The important effect of wind is evident.

Application of Environmental Test Results To Lighting Design

Reference to the curves in Fig. 2 shows that in every case the lamps, at the luminaire rating point, are operating substantially below their peak light output. It is well known that this fall-off in light takes place due to heating of the lamps, particularly in enclosing luminaires. However, the actual

extent of light fall-off is seldom known, and is often ignored in appraising photometric data. Proper appraisal of the photometric data of luminaires for outdoor service must include this factor. This is done by multiplying the photometric data by the peak percentage on the chart of light output versus ambient temperature.

A second factor is also important in proper appraisal of luminaires for outdoor service. This factor is the effect of variable weather conditions—temperature and wind. Unfortunately, no single value can express these weather effects. Specifically, it is quite incomplete to state the light output of a luminaire at particular temperatures, since this will vary widely with wind.

A method which provides an adequate luminaire appraisal is selection of the two severe weather conditions under which the luminaire will operate. One is a winter storm when low temperatures are accompanied by fresh winds. The other is a hot summer evening with a dead calm.

Just what values of temperature and wind should be considered for a particular locality? The *World Almanac* tells us that in Chicago, for example, the extreme temperatures recorded were 105 and —23 degrees. The extreme wind velocity was 87 miles per hour. There is a strong inclination to use extreme values such as these, or somewhat lesser extremes from one's own experience, as a basis of appraisal. However, this is misleading, since such extremes are rare and of short duration. Information available from the Weather Bureau relating temperature and wind to hours of occurrence provides a far more significant criterion. Such information, presented graphically for three United States cities, is shown in Figs. 3 and 4.

These curves show that temperatures in Chicago are above 83 degrees only 5 percent of the time, and

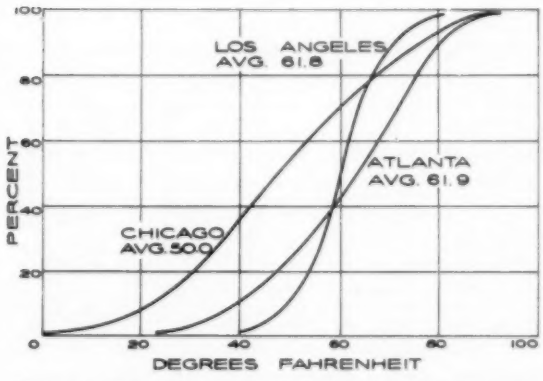


Figure 3. Portion of the time in the year that temperature is below the amount shown in the cities of Chicago, Los Angeles and Atlanta.

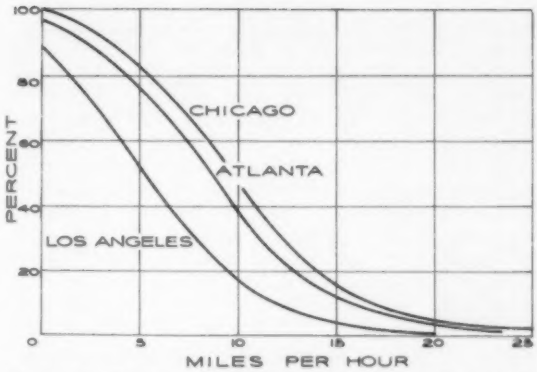


Figure 4. Portion of the time in the year that wind velocity is more than the amount shown in the cities of Chicago, Los Angeles and Atlanta.

below 18 degrees only 5 per cent of the time. Wind is above 20 miles per hour only 5 per cent of the time. On this basis, severe conditions of 18 degrees and 20 miles per hour on the cold side, and 83 degrees and calm on the hot side, might logically be selected. Since cold weather will not always be coincident with fresh wind, or warm weather with calm, conditions will be less severe than these during well over 90 per cent of the hours of the years.

The temperature curves of the luminaire with slimline lamps, (Fig. 2) shows that light output under the selected "severe cold" condition—18 degrees and 20 miles per hour—would be about 90 per cent of rating, or 68 per cent of peak. Under the selected "severe hot" condition—83 degrees and calm—the light output would be about 96 per cent of rating, or 73 per cent of peak. This unit would probably be considered acceptable. Indeed, such units are widely accepted in northern cities. However, some increase in lamp operating temperatures would be an improvement under Chicago weather conditions. The curves in Fig. 2b show that this luminaire produces higher lamp temperatures when equipped with two high-output lamps. Now the "severe cold" output is about 155 per cent of rating, or 99 per cent of peak and the "severe hot" output is about 97 per cent or rating, or 64 per cent of peak. This luminaire, equipped with two high-output lamps, would probably be considered too hot for the best attainable year-around light output in Chicago's climate. Interestingly, both units would operate above their photometric ratings most of the time.

A "Do It Yourself" Test For Temperature Characteristics

How is the luminaire designer to determine whether he has achieved a design suitable for

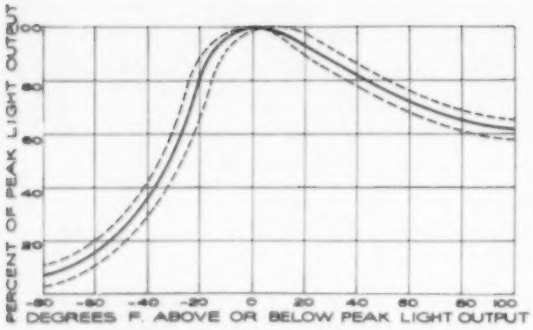


Figure 5. Typical light vs. temperature curve—composite of 82 curves of many different luminaires. Lamps included are argon-filled T12 in the 300-430 ma range and the 800-1000 ma range, and TD17 lamps at 1.5 amperes. Of more than 700 points all but 28 are within the dashed lines.

weather conditions in some region? And how is the application engineer to evaluate luminaires he may be considering?

Measurements in an environmental test chamber provide the answer to such questions with relatively high accuracy. In addition, by an empirical approach, predictions can be made of a luminaire's performance over a range of weather conditions based upon knowledge of performance at only one ambient temperature.

The curve of Fig. 5 is a composite of 82 curves taken during the last two years on luminaires of many different types. Lamps were argon-filled T-12's in the 300-430 ma range and the 800-1000 ma range; and TD-17 lamps at 1.5 amperes. Tests were made with a variety of commercial ballasts held at rated voltage. Of the 700 odd points plotted, all but 28 were within the dotted lines—that is, within either 5 per cent or 5 degrees of the curve. This suggests that a fairly good estimate of performance of these lamp types, as affected by ambient temperature, can be obtained by the assumption that this curve will apply to any luminaire employing these lamps. The procedure is simple:

(1) Attach a light cell to the luminaire close to the lamps. By choice of location and by baffling if needed, insure that it will not be affected by outside light or reflected light from the surroundings of the fixture. If this is done, the luminaire may be subsequently moved to another location for tests.

(2) Operate the luminaire for a period of about 100 hours to season the lamps and to obtain a stable condition in respect to the disposition of the mercury within the lamps.

(3) Hold room temperature and line voltage constant while the following test steps are taken.

(4) Read light on the cell.

(5) Turn the luminaire off and let it cool for at least one-half hour.

(6) Turn the luminaire on. Watch the light indication carefully. It should rise to a maximum value and then fall off to the value read in (4), above. Read the maximum value. The fall-off process may take another one-half hour or more depending upon the bulk of the luminaire.

(7) Divide the reading in (4) by the reading in (6) and multiply by 100, thus arriving at a per cent value.

(8) Mark this percentage on the curve of Fig. 5 at a point to the right of the peak value.

(9) Directly below this point, on the abscissa, write the room temperature at which the test was made.

(10) Mark other temperatures on the abscissa corresponding to this room temperature, using the same scale as in Fig. 5.

With the new abscissa scale, the curve is now a curve of light output versus ambient temperature under conditions of still air for the fixture tested.

The following example is illustrated in Fig. 6. If the first footcandle reading was 78 and the maximum was 100, 78 per cent would be obtained by dividing. If the room temperature was 80 degrees, the number 80 would be written on the abscissa below the point where the curve crosses the 78 per cent light output line. This would be directly above the 50-degree point on Fig. 5, showing that light output falls off to 78 per cent at a point 50F. above the temperature that yields peak light output. To complete the graph, 50 degrees is written above the present 20 degrees, 30 above the present zero, 10 degrees above the 20 degrees, etc.

In order to obtain greater accuracy a second reading is desirable. If during the winter a cold spell should occur, the luminaire might then be mounted in a garage or other unheated building

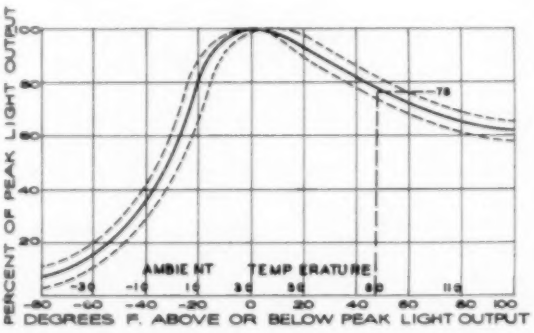


Figure 6. Typical light vs temperature curve—typical curve of Fig. 5 showing lapout to determine light output vs. ambient temperature of fixure which produces 78 per cent of peak light output at 80 degrees ambient.

which can provide still air conditions, and a second reading taken. The best reading in the example above will come from a test around 0-10 degrees since this will serve to locate the vertical portion of the curve which shows rapid fall-off of light at very low temperatures.

A similar procedure may be used to determine a curve of ambient temperature versus light output for a wind condition. Going back to the original interior room (around 80F), fans are arranged to blow on the luminaire. Wind velocity may be measured by fairly inexpensive equipment presently on the market. Repeat the ten-step procedure given above. In some instances, the light output may not reach a peak and then diminish in step (6). This indicates that the wind is cooling the lamps below their optimum temperature. In this case, determine the peak by turning off the fans and watching the light indication. Divide the stable reading from step (4) by the peak reading as before, but in step (8) plot it to the left of the peak in Fig. 5. A new abscissa scale is then determined in steps (9) and (10) as before.

Conclusion

Photometric data alone cannot adequately describe outdoor performance of fluorescent-lamp luminaires. An evaluation of the effect of weather on luminaire performance may be made by relating its environmental characteristics to Weather Bureau data, which provide frequency of occurrence of temperatures and winds.

Environmental characteristics of luminaires may be measured with relatively high accuracy in environmental test chambers. Lacking such a test facility, a simple estimating technique may be used to predict performance with fair accuracy.

Acknowledgement

The authors wish to express their gratitude to Messrs. K. M. Reid and C. M. Cutler for their assistance in preparing this presentation and to Mr. G. R. Baumgartner who inspired the estimating technique.

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6. *The World Almanac*, 1956, page 417. *The New York World-Telegram and Sun*, New York, N. Y.

DISCUSSION

C. W. JEROME:* For several years we have tried to stress the importance of proper ventilation, *i.e.*, proper temperature control for fluorescent lamp fixtures. As lamp manufacturers, we struggle to get each fraction of an lpw out of our lamps only to find in all too many instances that they are placed in fixtures or locations where they operate far below their intended efficiencies either because they run too hot or too cold. The present authors are to be congratulated for doing an excellent job on restressing this very important point. Their environment chamber has the advantage of being relatively simple although it is probably larger and more elaborate than most workers in the field can convince their companies they should build. I particularly like the provision for a continuous recording of the changes as they are taking place. As the authors point out such recordings often yield information that otherwise would be lost.

I have a few comments on the results. First, the rating point of fluorescent lamps has been intentionally made to be off the peak efficiency on the high temperature side. The bulb temperature is a function of the current in the lamp, and, of course, so is the total light output from the lamp. In this case, lamps are operated at higher currents than will give peak efficiency in order to take advantage of the increased high output. That is, a compromise has been made to get the most economical production of light from the lamp. This, incidentally, points up one major advantage of the construction of the extra high output lamp. The flexibility in construction of this lamp allows us to design it to operate at maximum luminous efficiency at its rated current and at an ambient temperature of 77F.

In some work I have been doing for the Light Sources Committee, I have been working over data on the effects of wind on fluorescent lamp operation and made an observation which may be of interest. That is, that the only effect of drafts is a cooling effect and tends to move the whole curve of light output vs. temperature one way or the other without changing its shape. For example, for normally medium loaded lamps such as the slimline lamps in Fig. 4a, the 20-mile wind lowers the temperature 25F, that is, moves the whole curve towards higher temperatures by this amount. This will be treated in more detail in a brochure of the Committee which we hope will be forthcoming soon.

The authors have been very judicious in their justification for eliminating the extremes of environmental conditions from general consideration for particular localities. It occurred to me that this could be carried even further in that lights in outdoor applications are not normally used during the daytime. Consequently, only prevailing nighttime conditions are important. Was this considered?

Apparently, ballasts were changed in the fixtures in the tests on commercial ballasts. Were these always placed in their normal position in the fixture? Temperature also affects ballast performance and it is important that they be measured in the environment in which they will be used.

A. W. WEEKS:** The importance of a technical paper can be evaluated according to the academic information and to the practical value in the particular field of endeavor. On this basis this paper is valuable and the authors are to be congratulated on their skillful handling of a complex subject. The portion of the paper "Do It Yourself" will certainly have practical and useful application in industry, as experience with the method described verifies its accuracy.

The curves shown in Fig. 2 indicate the light output of

*Sylvania Electric Products Inc., Salem, Mass.
**Champion Lamp Works, Lynn, Mass.

some of the lamps tested is well below 40 per cent of the rating point, and considerably further below the optimum under conditions of low temperature and 20 mph air movement. I am surprised that these lamps did not drop out before such low light output values were reached. The loss of light output in fixtures, shown by the difference between the "Rating Point" and optimum value on the curves, varies between 20 and 60 per cent. This is very disconcerting to a representative of a lamp manufacturer because they consider the loss of one per cent important.

I regret that the electrical and specific temperature information was left out, particularly the point at which temperature was taken, since this matter has been somewhat controversial. It is true that the practical application is best served by consideration of light output, but there is value in the economic consideration of the lumens per watt information. The electrical and temperature data from this comprehensive test would enhance the paper's value.

E. H. SALTER:* The authors are to be congratulated on collecting and analyzing data covering the performance of fluorescent luminaires under outdoor operating conditions, and especially on the suggested "Do it Yourself" method of determining probable perfomance of individual luminaire types. Such information should be very useful to those attempting to design luminaires for outdoor applications.

I am particularly interested in the composite curve in Fig. 5 which serves as the basis for the "Do It Yourself" procedure. Here the authors pointed out that "of 700 odd points plotted, all but 28 were within the dotted lines—that is, within either five per cent or five degrees of the curve." In other words, they are not proposing a single curve representing average luminaire performance, but a band within which a large percentage of luminaire performance data will fall. This is in accord with general testing experience with fluorescent luminaires where repeated tests of the same unit or of similar units will not always yield exactly the same light output under a given test condition.

It is, therefore, important that the user of this proposed system, of predicting performance realize that actual performance may not follow the solid line, though it may be expected to fall within the band represented by the dotted lines. In other words, there are certain tolerances that must be allowed in predicting luminaire performance under various temperature conditions.

M. E. KECK:** The authors are indeed fortunate to have such an excellent test facility at their disposal. They have done an excellent job, particularly in the first portion of their paper, in describing the problems facing the user of outdoor lighting equipment under the wide range and environmental conditions that it must encounter.

My only comment relative to the method of test is to add a word of caution that the light measuring devices must be located so as to sample, approximately uniformly, the light from all lamps within the luminaire if it is to accurately measure the relative output of the total luminaire under a variety of temperature conditions.

With relationship to choosing the most severe conditions in a particular location of the United States from Weather Bureau data such as shown in Fig. 3, I feel that the severe condition for winter operation may, in some instances, be the cold, no-wind condition, rather than a cold 20-mph wind condition. In the example which the authors choose for Chicago, they pick 18F and 20 mph. This would be the severe situation for the luminaire of Fig. 2a. However, for the luminaire of Fig. 2b, 2c, and 2d, the most severe condition would be +18F in still air. This choice, of course, depends upon the cross-over point of the two curves.

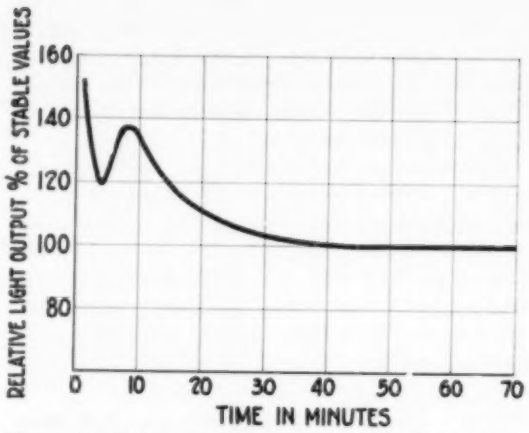

Figure A. Light output vs. time. Extra high output lamp in enclosed street light.

In the authors' description of the "Do It Yourself" test method, they give a verbal description of the light output vs. time characteristics of a lamp as it stabilizes. The accompanying Fig. A shows such an actual curve which was taken in our laboratory for an enclosed fluorescent two-lamp floodlight. I believe that it agrees quite closely with the authors' verbal description, and the maximum value to which they refer is the peak shown on my curve approximately eight minutes of operation.

In a paper by Underwood and Beck,[1] a quite different time output light curve is shown and does not agree at all with the authors' verbal description. I wish to indicate that I am with the authors of this paper as regards the correct time, light output, and curve characteristics.

Success of the "Do It Yourself" test, depends upon two factors, the first is that the peak shown on the curve of Fig. A of this discussion is actually the maximum light output which the luminaire will achieve under some unknown ambient temperature conditions. I have no proof that this is or is not the case. I believe that the authors should present some additional data relative to this point.

The other factor on which the success of this method depends is that all types of luminaires when used with all types of lamps do fall within the spread of Fig. 5 in this paper. In my opinion, they do not. The curve of the fixture in Fig. 2a when replotted and superimposed on the curve of Fig. 5 does not fall within the envelope. I feel quite certain that actual luminaires which incorporate auxiliary means such as fans, heat sinks, or thermal electric elements, would not fall within the envelope of this curve.

Fig. 5 is a composite of 82 curves but we do not know how many different types of luminaires, nor the range of the construction employed in those types are represented by that curve. This should be included.

In conclusion, I must state that I do not favor any attempt to over-simplify temperature data curves and to publish them without adequate testing to determine the true curve. I dread the thought of how easily a product could be misrepresented as to its performance characteristics by publishing a light vs. ambient temperature curve based on such an over-simplified and generalized approach.

*Electrical Testing Laboratories, Inc., New York, N.Y.
**Westinghouse Electric Corp. Lighting Division, Cleveland, Ohio.

I sincerely hope that the IES Testing Procedures Committee does not sanction such methods of arriving at publishable technical data.

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H. A. Van Dusen, Jr. and T. H. Leister: This paper describes factors involved in determining the effects of ambient temperature and wind on fluorescent luminaires and illustrates methods of using this data in field application of the luminaires. This data is of great importance for fluorescent luminaires as the effect of ambient temperature changes is often of sufficient magnitude to result in a 2:1 change of luminaire light output.

In order for photometric data to have significance, the temperature vs. light characteristics must be determined with a reasonable degree of accuracy. There are many potential sources of error involved in the measurement of the temperature and wind characteristics and the authors have recognized many of these. Of even greater importance is the fact that the authors have pointed out to the application engineer a need for intelligent use of light output vs. ambient temperature information as applied to photometric data for appraisal of luminaires for specific locales.

One factor mentioned by the authors on the application of the fluorescent luminaire is the method for determining optical efficiency of the luminaire. This can be described as the performance of the luminaire independent of the lamp performance. This is a very useful way of comparing luminaire performance and may be obtained by multiplying the total lumens from the luminaire at a given ambient temperature times a maximum percentage increase in light between the light output of the luminaire at that ambient temperature and the peak light output and dividing by the total lumens available. The total lumens available in most cases are the rated lumens of the lamps, since the lamp ratings are generally determined at or near the peak or optimum light output. This provides a method for comparing the performance of different luminaires using the same type of lamp and independent of ambient temperature effects.

Winds of low velocity have a very significant cooling effect and it is necessary to reduce air movement to a minimum in order to determine the performance of a luminaire in the "still air" condition. The authors say that there is less than 50 ft/min. air movement within their environment test chamber. This represents slightly over ½ mph wind velocity and although such a velocity is regarded by many as calm it can cause significant cooling on some luminaires.

It is admittedly difficult to maintain temperature control in a room without forced air circulation. A possible way to eliminate forced air circulation might be to use a double wall room where the cool air is circulated between the walls. The inner wall thus becomes a large radiating surface. It is also possible to provide a greater diffusing surface which can serve to reduce the movement of forced air circulation within the chamber to a very negligible value.

One method which we have found to be satisfactory for obtaining the correct test temperatures is to cool the room to the lowest temperature using as much air circulation as desired and then shut down the circulating system and let the room warm very slowly to the high temperature limits while measuring the performance of the luminaire. Electric space heaters may be used as necessary.

By this process the room is not held at any specific temperature but is constantly changing. However, if the rate of change is sufficiently slow (48 hours typical for full range of temperature), the effect of thermal lag on the luminaire is negligible. By this process there is no air movement except the natural convection currents.

The use of the portable wind tunnel is excellent. The use of such a small cross-section is a serious limitation that the authors recognize. However, I would like to emphasize that it is important that the test section area of a wind tunnel should be large as compared to the specimen area, otherwise significant errors in determining effective wind velocity may occur. Also, the air flow pattern may be very significantly changed from the free flow condition, thus changing its cooling characteristics.

We have been measuring the effects of wind and temperatures on the light output of fluorescent luminaires by use of an outdoor test installation. In such an installation it is difficult to obtain accurate values because ambient temperature, wind velocity, and direction are constantly changing. By evaluating a large amount of such data, however, we have found that the effect of wind on light output is almost maximum at 10 mph. Higher wind velocities have very little additional effect. I wonder if the author's observations with their wind tunnel bear this out.

Our procedure for testing the characteristics of fluorescent lamps in an environment chamber is to start the luminaire at the high ambient temperaure while maintaining a high air velocity by the use of blowers and fans (we use sufficient air velocity so that an increase in velocity results in no measurable change in light output). With this air circulating we very slowly reduce the ambient temperature to its lowest value. This gives us the light output vs. temperature characteristics of the luminaire for the high wind condition (which we classify as 10 mph and over). Allowing the environment chamber to warm slowly with all blowers shut off then gives us the still air condition.

During the environment chamber test, we record ambient temperature, lamp chamber temperature, ballast chamber and any other temperatures desired vs. time on one recorder, while recording the relative light output vs. time on a current balance recorder. A current balance recorder tends to eliminate errors due to non-linearity of photocells when loaded with a resistance.

We are in agreement with the recommendations that recorders be used for obtaining data from environment chamber tests. There are many transient effects that could be completely overlooked if data were obtained by manually reading the instruments, especially considering the very long time required to go through one test cycle.

The "Do It Yourself" test is an interesting side light. We compared curves of light output vs. temperature of several of our luminaires with curves derived by the "Do It Yourself" test. Using 77F still air ambient temperature as a starting point, we found:

(1) With a luminaire having four 1000ma high output lamps, the predicted and actual curves had about the same shape, however, predicted curve peaked at a temperature 15 degrees higher than the actual measured curve.

(2) Using a luminaire having two 1.5 ampere lamps, the predicted and actual curves peaked at the same value, but varied about five per cent in between starting and peaking points.

(3) Several luminaires had a light output at 77F less than 60 per cent peak value and since the "Do It Yourself" curve does not extend into this region, the comparison cannot be made.

The "Do It Yourself" test shows a surprising degree of agreement with actual performance of the fixtures falling

*Line Materials Industries, South Milwaukee, Wis.

within the range of the authors' curve. This can be a handy tool for preliminary estimation of luminaire performance.

R. P. TEELE:* The authors have done a very useful piece of work and have done it thoroughly. The composite curve shown in Fig. 5 and their "Do It Yourself" test should prove very useful.

The authors make a comment on the effect of temperature on selenium cells. They found that "With the paddle of four cells, connected across the 100-ohm potentiometer, and illumination levels of 50 footcandles or more, the effect of temperature on the cells has been found to be negligible." In Weston's technical data on selenium cells are given the conditions of load which bring about an essentially zero temperature coefficient. For example, a single cell across 300 to 500 ohms with about 20 footcandles illumination will show this effect.[1] The four-cell paddle used in this work loads the cells to about this same condition. In work covering a range of temperatures an effort should be made to obtain the desired loading for negligible temperature coefficient.

Some words of caution in using selenium cells in parallel should be mentioned. Trouble may be encountered if one or more of the cells have a low back resistance (the resistance measured by passing a small current through the cell while dark in a direction opposite to the normal direction of flow). Satisfactory cells should have a back resistance of at least 30,000 ohms, for use in other than a zero resistance circuit. When cells of widely different back resistance are operated in parallel, trouble is very likely to occur.

1. Zworykin, V. K. and Ramberg, E. G.: "Photo-Electricity," p. 213, John Wiley and Sons, Inc., New York, N. Y. (1949).

P. R. HERRICK AND R. E. WENNER:** We should like to thank the commentators for their interest and their kind remarks.

Mr. Jerome's comments regarding extra high output lamps are well taken. Temperature control of all extra high output types is achieved by special features in their construction, without which these lamps would be inefficient indeed. Not only the lamp designer, but also the fixture designer, must be vitally concerned with this question of lamp temperatures. As Mr. Weeks points out, the losses in light due to operation at other than optimum temperatures is disconcerting. Even in indoor applications fluorescent lighting is subjected to considerable range of ambient temperatures. We must be concerned not only with the ratings under photometric laboratory conditions but with the general performance of fluorescent lighting under field conditions. Since the loss of light output and efficiency is considerably more severe at temperatures below optimum than at temperatures above optimum, it is best that the lamps operate somewhat warmer than optimum under average conditions.

The authors' data confirm Mr. Jerome's observation of the displacement of a constant shaped curve by wind. The amount of the displacement for any particular wind velocity depends on both the lamp and luminaire loading. Fig. 2 shows that the displacement is greater for the luminaire with four high output lamps than for the same luminaire with two high output lamps. This assumption of a constant shape curve which may be displaced to the right or left by winds or fixture modifications is very useful, and of course is the basis of our "Do-it-Yourself" estimating technique. However, it is important to remember that while this is an assumption of adequate engineering accuracy for many purposes, it is by no means an absolute physical truth. This is the reason that our approach to the problem has been entirely empirical. Mr. Salter's statment on the subject cannot be improved. We can only add "take heed."

Mr. Keck's observation that the curve of Fig. 2a does not fall entirely within the envelope of the typical curve is correct in that curve 2a deviates somewhat to the left of the envelope between 0F and —30F, reaching a point some five degrees to the left at about —10F. Since this curve is part of the composite, it no doubt represents two or three of the 28 points out of 700 which fell outside of the envelope. From a statistical standpoint, this probably impugns the accuracy of curve 2a more than the validity of the composite. The composite curve includes most of the popular types of fluorescent flood and street lighting luminaires as well as special applications such as gas pumps, phone booths, signs, etc.

In our opinion, our verbal description of the warm-up characteristic would apply equally to the curves shown by Mr. Keck and those presented by Underwood and Beck in their paper. The peak to which we refer is shown on neither Keck's nor Underwood-Beck's curves because of the long time scale they used. The peak to which we refer would occur in the first minute of these curves. Repeated determination of this characteristic in connection with environmental tests by the authors indicates its reliability for estimating the temperature characteristics of the lamp types listed in the paper. We do not believe that this estimating technique is necessarilly valid for any other lamp types not mentioned in the paper, and, of course, any luminaire employing a fan or other thermostatically-controlled cooling device will have a discontinuous temperature vs. light characteristic quite different from the typical curve. The authors certainly agree with Mr. Keck's sentiment that published performance characteristics of any product ought to be based upon rigorous testing and not upon any estimating procedure.

Mr. Jerome's idea of considering the temperature and wind conditions only during the period when the luminaires are operated would certainly result in a greater precision of analysis. The Weather Bureau offers us only totalizations based on total monthly figures including all 24 hours.

Happily the luminaire used as an example in this paper was designed for extra high output lamps and used the two-case ballast, then in vogue. Thus, we were able to keep the ballast in approximately the same location for all tests, as Mr. Jerome indicates would be desirable.

The authors likewise regret that space did not permit the inclusion of some of the considerable volume of data on bulb wall temperatures and electrical characteristics which have been taken. However, we may add that with the minimum bulb wall temperature at any point on the lamp as our criterion, our data are in good agreement with the curves published by Mr. Jerome in 1955.

We do not feel that our test chamber could be used as Mr. Van Dusen describes (for a still air test) since our rate of chamber rise between —40F and 40F would take place in about eight hours. Using a more insulated chamber with a rate of warm-up of about four degrees per hour could lead to valid results, since we might expect bulb wall temperature in an enclosed fixture to follow the ambient temperature at this rate. As a precautionary measure, the air temperature adjacent to the fixture should be measured, since the air temperature may tend to stratify under this calm condition. With enclosed fixtures we have noticed no effect on light output when the blowers are turned off.

Our tests show that in general, increase in wind above ten miles per hour will have a small additional effect on light output. This is particularly true for exposed lamps; however, with large bulky fixtures we have found it desirable to use at least 15 miles per hour for a severe test condition.

*National Bureau of Standards, Washington, D. C.
**Authors.

Performance Characteristics of

Combination Air-Diffusing Troffers

By M. L. QUIN
W. W. KENNEDY

A RAPIDLY advancing architectural trend toward greater freedom in space planning is creating a new demand for flexibility in service systems. Previous thinking in terms of shifting ceiling components to suit movable partition changes is giving way to the self-sufficient planning module. An example of this planning is the 5-foot x 5-foot module, any multiple of which may be combined to provide a complete luminous, thermal and acoustical environment within the resulting enclosed spaces.

The continued use of suspended ceilings to provide acoustical control has, for aesthetic reasons, created a desire for lighting and air-handling functions to be combined into a single flush-mounted element in the center of each module. Moreover, a trend toward clean and uncluttered ceilings has extended this integration of sources to buildings not necessarily designed for multifunctional interiors.

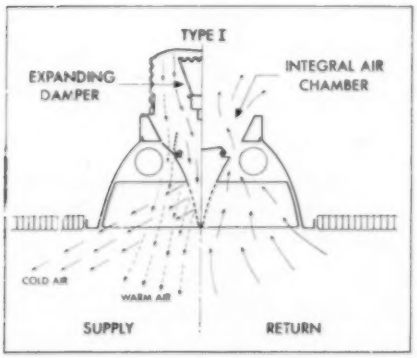
Light and air-diffusing performance characteristics of combination units hold many aspects which are of mutual interest to both professions. In this paper, the authors hope to contribute to the advancement of knowledge relating to this technology.

A paper presented at the National Technical Conference of the Illuminating Engineering Society, September 7-11, 1959, San Francisco, Calif. AUTHORS: Day-Brite Lighting, Inc., St. Louis, Mo., and Barber-Colman Co., Rockford, Ill., respectively. Accepted by the Papers Committee as a Transaction of the I.E.S.

Diffuser Types

For nomenclature clarification, the term "diffuser" will herein refer to a troffer which functions in the dual role of distributing both light and air. Two such diffusers are shown in Figs. 1 and 2, each of which is sectionalized to illustrate air flow paths. As dictated by integration requirements, each diffuser may operate interchangeably as a supply outlet for conditioned air or return outlet to exhaust room air. Two diffuser types have been selected to illustrate the difference between integral and separate air chamber designs.

An integral air chamber is illustrated in Fig. 1 with a 12-inch wide louvered parabolic troffer having a perforated longitudinal reflector-diffuser. Lateral divergence of the primary air stream most suitable for cold air delivery is obtained by pressurizing the perforated diffuser. Downward deflection of the air stream for warm air delivery is achieved by opening adjustable vanes above the perforated diffuser. The resulting convergence of air streams channeled through a combination of air passages provides the desired downward deflection. Since diffuser perforations would tend to clog with dirt carried in return air, these same adjustable vanes are positioned to close off the diffuser, allowing the return air stream to bypass it and gain direct entrance to the air chamber.



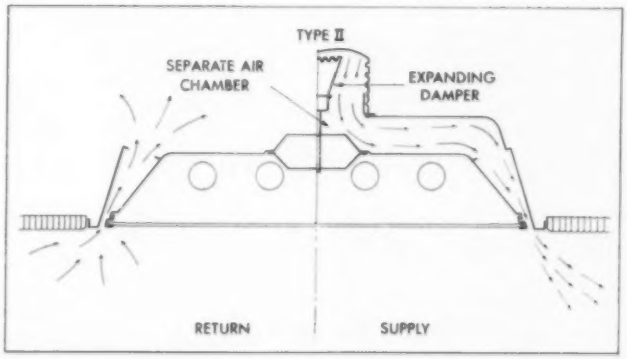
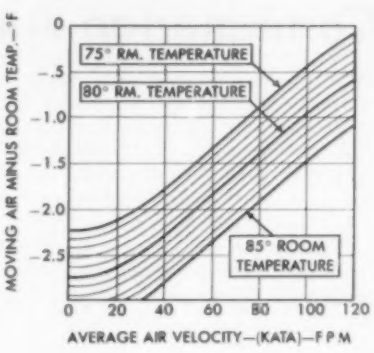


Figure 1 (left). Half sections of a louvered diffuser showing air flow through an integral air chamber.
Figure 2 (right). Half sections of an enclosed diffuser showing air flow through a separate air chamber.

TABLE I — Comprehensive Selection Table and Comfort Chart. Diffuser Selection Based on the Proper Relationship Between Air Velocities and Air Temperatures Necessary for Human Comfort.

T/D COOLING °F	DIFFUSER TYPE	MINIMUM MOUNTING HEIGHT																					
		8'-0"			9'-0"			10'-0"			11'-0"			12'-0"			13'-0"			14'-0"			15'-0"		
		A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
30	I	50	.02	15	50	.02	15	75	.04	24	75	.04	24	90	.06	28	90	.06	28	100	.075	31	100	.075	31
	II	50	.04	16	50	.04	16	75	.10	24	75	.10	24	90	.14	28	90	.14	28	100	.17	30	100	.17	30
25	I	70	.04	22	80	.05	26	80	.05	26	80	.05	26	100	.075	31	100	.075	31	100	.075	31	150	.16	40
	II	70	.09	22	80	.11	25	80	.11	25	80	.11	25	100	.17	30	100	.17	30	100	.17	30	150	.40	38
20	I	80	.05	26	100	.075	31	100	.075	31	125	.11	36	125	.11	36	150	.16	40	150	.16	40	150	.16	40
	II	80	.11	25	100	.17	30	100	.17	30	125	.27	35	125	.27	35	150	.40	38	150	.40	38	150	.40	38
15	I	90	.06	28	100	.075	31	100	.075	31	125	.11	36	125	.11	36	150	.16	40	150	.16	40	150	.16	40
	II	90	.14	28	100	.17	30	100	.17	30	125	.27	35	125	.27	35	150	.40	38	150	.40	38	150	.40	38
10	I	100	.075	31	150	.16	40	150	.16	40	150	.16	40	150	.16	40	150	.16	40	150	.16	40	150	.16	40
	II	100	.17	30	150	.40	38	150	.40	38	150	.40	38	150	.40	38	150	.40	38	150	.40	38	150	.40	38
0	I	150	.16	40	150	.16	40	150	.16	40	150	.16	40	150	.16	40	150	.16	40	150	.16	40	150	.16	40
	II	150	.40	38	150	.40	38	150	.40	38	150	.40	38	150	.40	38	150	.40	38	150	.40	38	150	.40	38

A = MAXIMUM C F M PER DIFFUSER
B = PRESSURE DROP IN INCHES OF WATER
C = NC NUMBER (NOISE CRITERION CURVE)



A separate air chamber is illustrated in Fig. 2 with a 24-inch wide glass or plastic enclosed troffer. Duct-like side air compartments provide for complete separation of the lamp compartment and air chamber. Longitudinal throat pressure is equalized by a series of discharge apertures paralleling each side of the enclosure frame. Individual side air compartments receive supply air through a separable air chamber common to both. By omitting this chamber, room air may be exhausted directly into the ceiling cavity. However, each diffuser may exhaust room air through duct return systems by duplicating supply connections.

Air Distribution and Comfort

Proper air distribution contributes much to the comfort of the occupants of a space and its importance can not be overly emphasized. The concept of comfort as it relates to air distribution will vary between individuals and even geographical areas. The important factors are temperature, air motion and relative humidity within generally accepted limits established through research by the American Society of Heating and Air Conditioning Engineers[1] and several industrial laboratories.

Diffuser Selection

There are as many as fourteen factors[2] that may enter into the selection of a diffuser, several of which are of sufficient importance that they can not be ignored. Through comprehensive tests of the diffusers in a space simulating actual conditions, including variables which may be encountered, a simple selection table has been compiled, see Table I.

Performance tests were made in a specially constructed 20-foot x 20-foot room equipped with heating panels to maintain a constant temperature of 75F. Air was supplied through the diffusers at predetermined air volumes and temperature combinations. Temperature and velocity readings throughout the space, Fig. 3, were recorded using thermocouples and hot wire anemometers.

In addition to the temperature and velocity readings, anhydrous HCL gas and ammonia were introduced into the primary supply system to form

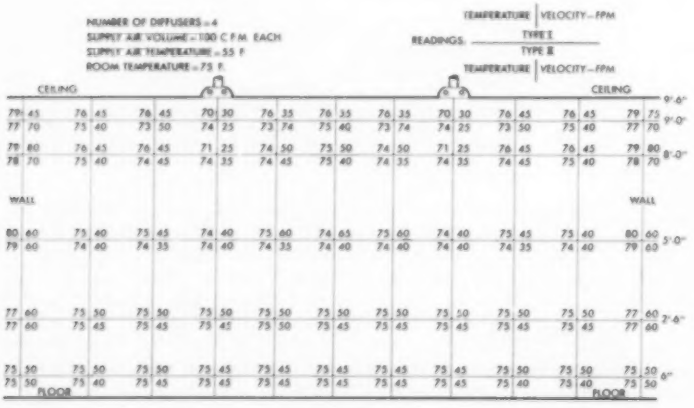


Figure 3. Typical air temperature and velocity traverse with four diffusers in a 20-by 20-foot room.

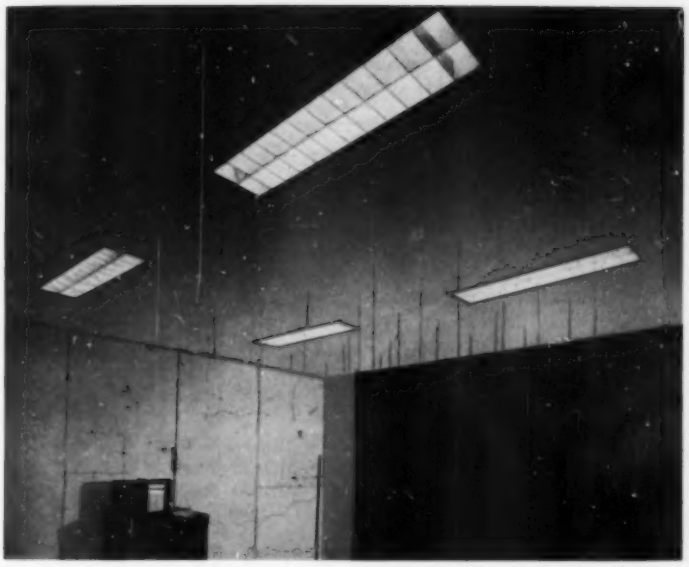


Figure 4. Test room equipped for recording temperature and velocity traverses.

a dense white smoke permitting visual observation of the air patterns and diffusion of the air in the space. Tests were conducted using a single diffuser as well as various other arrangements up to and including four diffusers as shown in Fig. 4. Each diffuser to be used in the selection table was required to perform within the limits of the comfort chart shown to the right in Table I.

In air distribution for cooling, usually detectable air motion in the space is accompanied by a depression of the dry bulb temperature below that of the surrounding area. Certain combinations of air motion and temperature depression are undesirable, resulting in complaints of drafts. In the selection of diffusers, these conditions must be avoided, making it necessary to have some standard on which to base the performance.

The comfort chart is used for this purpose and is the result of extensive research. It is based on the reactions of a number of people normally clothed and engaged in light work as in the average office. This chart has been used extensively and experience in the field shows it to be a reliable guide in the evaluation of the air distribution equipment.

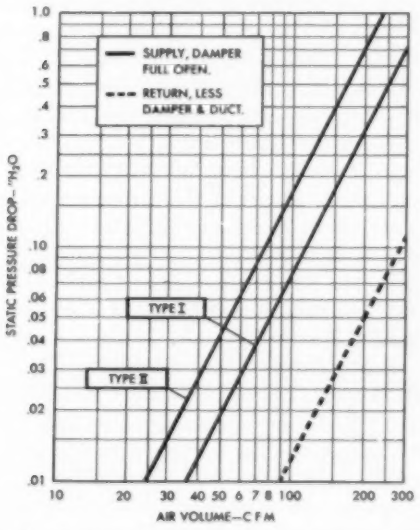


Figure 5. Pressure drop chart showing resistance of diffusers to air flow.

Pressure Drop and Noise

The pressure required to discharge air through a diffuser, or pressure drop as it is usually referred to, is often given more weight than is justified. It is unlike the pressure loss through the duct system where the resistance of each component is additive in that it is only considered once in design calculations. A normal pressure drop through the diffusers as shown in Fig. 5 is desirable since it aids in system balance and control of the air pattern.

The pressure drop shown in both the selection table and Fig. 5 is through the diffuser and damper only. The measurement is made at a point 12 inches above the top of the unit with the damper in the fully open position. In some applications the entrance loss to the branch duct and the resistance of the branch may exceed that of the diffuser and must be considered in the system design. This is particularly true where the diffusers are selected for use at the higher capacities.

Noise, or lack of noise, is receiving a great deal

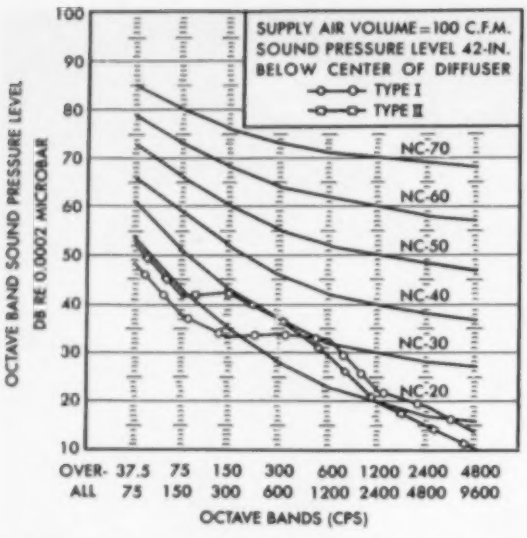


Figure 6. Noise Criterion curves illustrating diffuser sound pressure levels in eight octave bands.

of attention at this time as acoustical problems become better understood. The modern building located away from congested areas may, due to lack of background noise, provide an uncomfortable space. Pleasant background noises are helpful in making a space seem quieter than it actually is and in reducing unwanted sounds from adjacent areas. Much attention is now being given to increasing the background level which is referred to as "acoustical perfume."[3]

The diffuser might well supply some of the "acoustical perfume" and the designer will be interested in obtaining a uniform broad band sound. The data in Fig. 6 were obtained with the microphone of the sound level meter located 42 inches directly below the center of the diffuser. All tests were made in an anechoic chamber designed for this type of investigation, and the data are plotted on Noise Criteria Paper to show the shape of the spectrum. The single NC rating in the selection table is based on the sound pressure level at the 1200-2400-cycle band with the NC curve drawn through the peak of the spectrum.

Relative Light Output

Much data have been published reporting the relation between light output and bulb wall temperatures of fluorescent lamps and how these in turn are affected by ambient temperatures.[4,5] It has also been shown that lamps rarely enjoy optimum conditions within luminaires due to the restriction of convection currents, heat gain from ballasts and adjacent lamps and, in the case of enclosed luminaires, trapping of radiant energy.[6,7] In general, these adverse thermal factors are more prevalent in troffers than other luminaire types.

A third variant affecting light output may be found in air motion. Although this factor is seldom encountered in building interiors, the interrelationship between air motion, ambient temperature and bulb wall temperature becomes a determining factor in relative light output of combination diffusers. Of these, air motion and ambient temperature are more directly related since convective dissipation increases with air velocity. Tests indicate, however, that the effect of this action is dependent upon diffuser type and upon the temperature differential between moving air and ambient temperatures.

Relative light output vs. air temperature and velocity tests were conducted with diffusers mounted in ½-inch-thick wooden boxes in accordance with the Underwriters' Laboratories standard practice for thermal testing of flush-mounted troffers. Conditioned air was supplied and room air returned through the diffusers with 5-inch flexible duct in 25-cubic-foot-per-minute increments beginning at 25 and extending through 150 cfm. The 15-foot x 19-foot test room ambient was maintained at a constant 77F. For purposes of these tests, the diffusers were equipped with 40-watt T12 rapid-start fluorescent lamps.

Relative light output curves for both diffuser types are shown in Fig. 7 with per cent of change based upon output under static conditions. The magnitude of change in light output resulting from air flow through the Type I diffuser, having the integral air chamber, shows the greatest variation. Although the primary cold air stream is discharged below lamp level, some aspiration does occur around each lamp. This secondary air motion combines with the radiating effect of cooled metal surfaces to reduce the immediate ambient at the lower air temperature and higher velocity extremes.

The air velocity factor has relatively little effect on lamp performance in this diffuser type during warm air supply or exhaust functions, although the air stream is induced to flow past the bulb wall (see Fig. 1). The range of light output during the exhaust function is a bar, the upper and lower limits of which are inscribed within a circle on the performance curve.

Relative light output curves for the enclosed diffuser, Type II, are illustrated for both two and four lamps. Here, the convective action of air flow through separate air chambers outside of the lamp compartment produces a relatively constant light output value, varied more by air temperature than velocity throughout the greatest portion of the re-

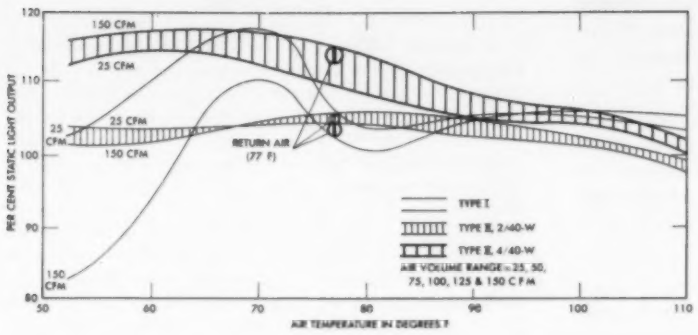


Figure 7. Effects of air temperature and velocity on relative light output.

corded operating range. This is shown by a performance variable of only 2½ per cent of static light output between 25 and 150 cfm at the peak of the four-lamp diffuser curve. The 117 per cent maximum, obtained with 60F air at 150 cfm, is the product of a reduced lamp compartment ambient temperature more closely approaching the optimum conditions at which lamps are rated. Direct application of these results, and those relating to heat transfer ratios, would be somewhat misleading since air temperatures surrounding troffers in wooden test boxes are generally higher than ceiling cavity temperatures.

It may be assumed that a greater portion of the heat load normally transmitted upward will be transferred into the air stream. Conversely, diffusers functioning as return outlets will remove a similar portion of the heat gain normally radiated into the conditioned space. In general practice, however, the total lighting heat load is calculated as being within the building proper, portions of which cannot be discounted unless exhausted outside or converted to a useful purpose.

Ballast Temperature Characteristics

The thermal environment in which a fluorescent ballast operates in a combination diffuser is unique in comparison with other luminaire types. Today, much attention is being directed to the ballast overheating problem and particularly the short life expectancy resulting from insulation deterioration after long exposure to excessive heat.[8] It follows that diffusers intended for connection to year-round air conditioning systems for both cooling and heating should be submitted to rigorous testing.

In accordance with standards and code requirements, a diffuser must provide for complete separation of electrical and air-handling compartments. As a further safeguard, ballast case temperatures may not exceed the allowable 90C maximum when operating within a diffuser handling low volume hot air. The Underwriters' Laboratories' tests have used an upper limit requiring normal operation with 200 F input air for unlimited listing to guard against unusual conditions of temperature control, short duct runs or unbalanced distribution systems.

Heat dissipation devices must be utilized on 4-foot diffusers to achieve this performance with present-day ballasts. Obviously, lower than normal ballast operating temperatures may then be expected throughout the normal heating and cooling cycles of central systems. Fig. 8 analyzes maximum case temperatures recorded for both diffuser types during air handling and static conditions. Thermal recordings were made concurrently with

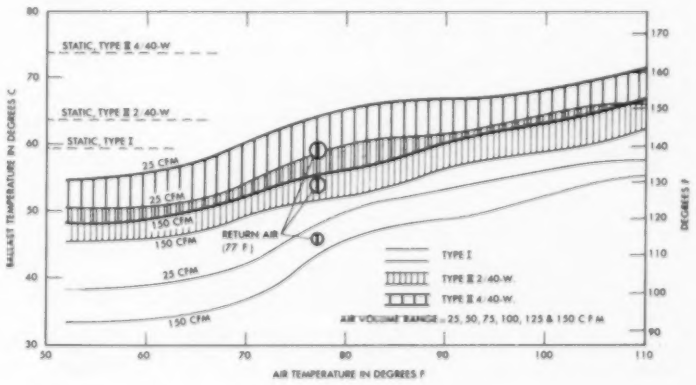


Figure 8. Effects of air temperature and velocity on ballast operating temperatures.

relative light output readings with diffusers mounted in suspended wooden test boxes.

Ballast temperatures were found to remain relatively constant throughout the 25- to 150-cfm range, varying more by air temperature than velocity. If temperature coefficient of insulation deterioration rates were applied to these findings, ballast temperature-life expectancy should extend considerably beyond that normally anticipated.

Summary

The authors wish to point out that the integration of light and air diffusing sources is not intended as a complete replacement for other methods of delivering these services separately to interior building zones. Moreover, the fundamentals of good air distribution and lighting practices need not be sacrificed in the design of combination equipment. The wedding of these elements is not new—rather, it is the product of an advancing mechanical technology stimulated by architectural desires for a greater freedom in space planning, multi-use of prefabricated materials and aesthetic refinements in the appearance of ceiling components.

Other investigations are underway which will lead to a better understanding of maintenance factors and heat transfer ratios. It has been established by tests and observations that ceiling smudging tendencies can be nullified. Accelerated lighting maintenance tests have been in progress for some time; however, it is too early for accurate conclusions to be drawn on all performance phases.

Acknowledgments

The authors wish to acknowledge with grateful appreciation the cooperation of A. W. Schach, R. D. Bradley and their combined laboratory staffs for their assistance in compiling test data and observation. Sincere thanks also to E. N. Picker for his rendition of these results.

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DISCUSSION

L. A. ARCHER:* Whereas it is true that the fundamentals of good air distribution and lighting practices need not be sacrificed in the design of combination units, it is also true that with a proper marriage of these elements an over-all architectural gain can be made. I wish to extend sincere congratulations to the authors for their excellent coverage of the factors necessary to the proper integration of these elements.

In order to obtain the maximum potential of combined units, it is advisable to take advantage of the specialized knowledge and ingenuity of the architectural, electrical, and mechanical engineering team engaged in the use of these units. One way to do this, is to provide application information which illustrates the characteristics of the various combined units and allows these engineers the freedom to design toward unforeseen goals. With this in mind, we would like

*Pyle-National Co., Chicago, Ill.

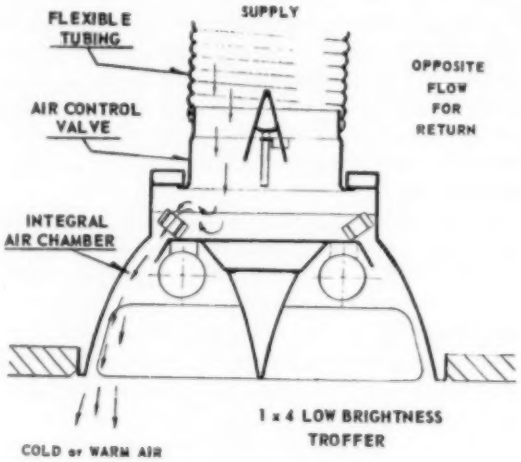

Figure A. Low brightness combined unit where air passes through lamp cavity of troffer.

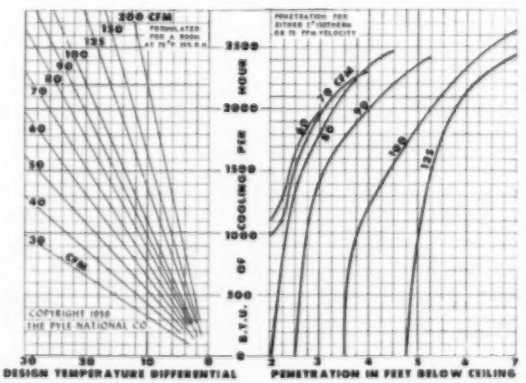
DESIGN TEMPERATURE DIFFERENTIAL
PENETRATION IN FEET BELOW CEILING
B.T.U. OF COOLING PER HOUR
COPYRIGHT 1959 THE PYLE NATIONAL CO.

Figure B. Diffusion capacity chart for one- by four-foot troffer.

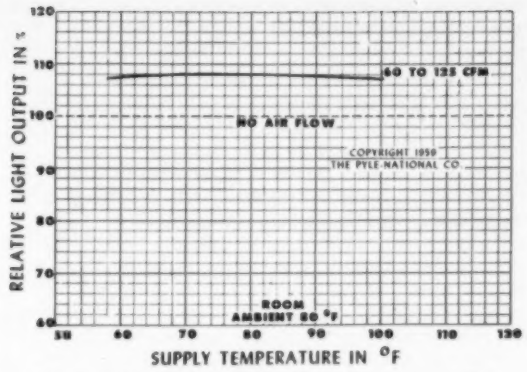

Figure C. Light chart for one- by four-foot troffer.

to present additional information illustrating the characteristics of combined units.

All of the combined units with which we have had experience display performance differences, but they have similar characteristics. Therefore, in the interest of brevity, the curves for one illustrative model will be used.

Fig. A illustrates a low brightness combined unit in which the air passes through the lamp cavity of the troffer. This air utilizes the same passages for either supply or return applications. These passages have been developed to secure an optimum prformance within the three design parameters of air distribution, lighting efficiency, and quiet operation.

Fig. B illustrates the air diffusing characteristics of this unit over the anticipated range of operating conditions. This chart shows that usually the combined unit will handle a greater cooling load, with a given ceiling height, if the air quantity is reduced and the temperature differential is increased. This is contrary to what one may have expected. This chart also enables the engineer to make intelligent interpolations for conditions other than those tested.

Fig. C illustrates the change in light output for changing conditions of air supply temperature and air quantity. The 100 per cent reference was established by a footcandle reading at no air flow with an 80-degree fixture ambient which was the same as that used in the preparation of the utilization factor. The relative readings were then made with a fixture ambient which was a normal amount greater than a room temperature of 80 degrees. While this gave less of a gain over the static reading, it is believed to be representative of normal installation conditions. Readings with a pine box give the same basic characteristics, and the important thing is that the percentage figure be applicable to the utilization factors involved.

This particular unit shows no perceptible change in light output with respect to air quantity and very little change with respect to temperature. This is not the usual case, but it illustrates what can and has been done toward control of tube ambient in units of integral case design.

Fig. D illustrates the total friction drop of this unit including the entrance loss from the duct and the specified length of tubing. The curves for various valve positions are given to indicate the range of control available to the designer of the duct system.

Fig. E is a sound characteristic for this unit based on the sound power generated by the diffuser. Just as light can be measured in footcandles at a point, sound can be measured in pressure at a point. Also, just as a light is rated in candlepower, a sound generator is rated in sound power. The frequency spectrum of a sound may be compared to the color of the light from a source. Both light and sound follow the inverse square law, and lighting engineers apply their specialized training to the sound subject with ease. The rest of us have to work at it a little harder. Understanding is sometimes hampered by the fact that sound power, sound pressure, and the sound frequency spectrum are all given in decibel units.

The easiest way to measure sound power and sound "color," is to use a reflective room which might be compared to an integrating sphere. The engineer can then use this sound power to calculate the resultant sound pressure in a space, of predictable sound absorption, due to any number and location of diffusers. This calculation procedure is simple, but usually not worth the time for the small sound contribution of these units. For this reason, the sound power of Fig. E has been reduced to that encountered in a live room comparable to an average office. A room with an absorption factor greater than 100 would yield lower sound readings, and the calculation could be made if warranted.

The sound power is plotted using the arithmetic sound power ratio to illustrate the characteristic. The logarithmic decibel value is also given. The sound power for various

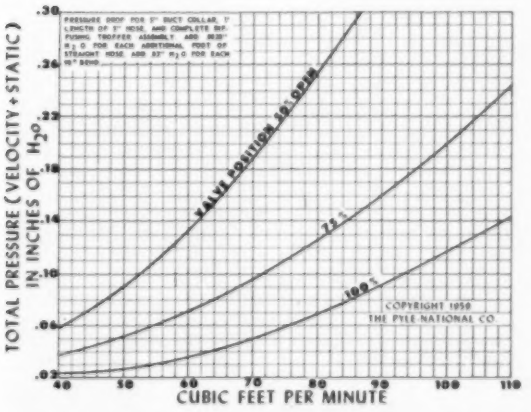

Figure D. Pressure chart for one- by four-foot troffer.

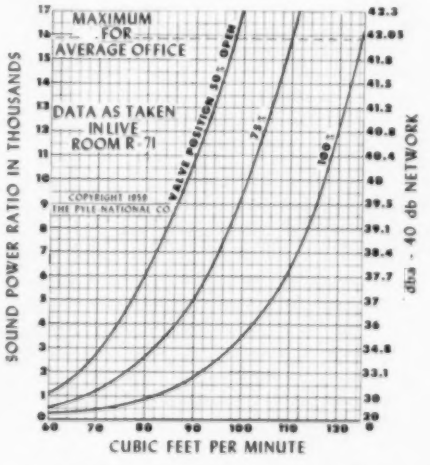

Figure E. Sound chart for one- by four-foot troffer.

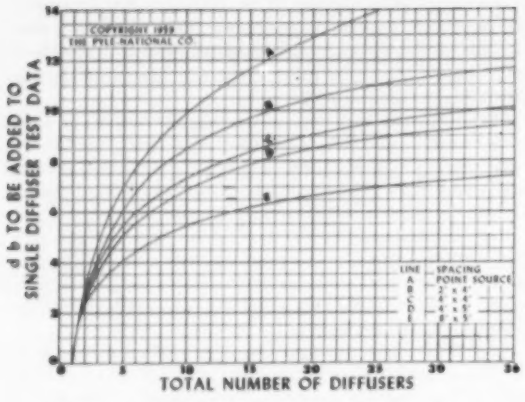

Figure F. Multiple diffuser sound correction.

valve positions is given to illustrate the importance of balancing the system with reasonable valve openings.

Fig. F is a correction factor chart for use in increasing the sound power values of Fig. E to compensate for multiple diffuser installations. Even though it is based on the free field sound rules, it yields results that agree reasonably with those obtained by the calculation method outlined in the "Guide."

Since octave analysis of the sound from low velocity air diffusers yields results which are of the general shape of the noise criterion curves, and since these diffusers generate very little noise, the value of the octave analysis becomes small compared to the increased test labor. A "color" check at a high flow rate is all that is really necessary and is often all that can be obtained, because our normal environment also yields an octave analysis in the shape of an N.C. curve.

Fig. G shows an installation in the Indiana State Teachers' Association Center, Indianapolis, Ind., which illustrates the results which can be achieved using air diffusing troffers. This installation combines excellent lighting and air conditioning in an architecturally uncluttered ceiling which will remain free of smudging and give a maximum of freedom in the placement of partitions.

GORDON C. HARVEY:* From a ballast manufacturer's viewpoint, this is a most interesting and informative paper, because it shows so well how by control of lamp heat, light output can be improved, ballast temperatures reduced and audible hum masked. Each of these elements causes the ballast designer daily problems, so it is gratifying to see the potential relief shown here.

I assume the authors have considered a solution to the UL problem that may be posed by the use of 200F air. It is difficult for me to see how this 93C air in contact with a ballast housing being heated by lamps and ballast losses can pass the 90C case temperature limit requirement.

With regard to noise, and especially the opportunity to use "acoustical perfume," it seems to me that this feature, which is apparently built in, will be very useful. However, some application data to correlate apparent environment, the masking noise and ballast sound ratings will doubtless be worthwhile.

With further regard to noise, it is not clear to me how the NC levels shown in Table I for the two diffuser types correlate with curves shown in Fig. 6. Is it possible that these curves are labeled incorrectly?

It is pointed out that ballast heating is largely influenced by air temperatures rather than velocity. This is probably influenced by the apparent need to enclose ballasts so that air does not come in direct contact with them. In the data shown, ballast temperatures in Type II (two 40-watt luminaires with 25 cfm air at 90F) begin to exceed that obtained in static conditions. This points out that the system designer may profitably give some thought to the economic balance of over-all design cost to effect lower ballast temperatures by using a one-half life 10C rule applied to a life expectancy of 10 or 12 years under good normal operating conditions.

E. H. WITTE:**I would like first to commend the authors on a very well done and timely paper. The architectural trend toward modular planning, the higher footcandle levels

*General Electric Co., Ballast Dept., Danville, Ill.
**Benjamin Electric Mfg. Co., Des Plaines, Ill.

Figure G. Installation at Indiana State Teachers' Association Center showing application of air diffusing troffers.

now in use and the demand for cleaner, less cluttered ceilings make this paper of interest to all illuminating engineers. The enthusiastic acceptance of combination troffers over the past three years is further proof of this.

I would ask several questions of the authors:

(1) Fig. 1 shows a Type I diffuser with adjustable deflectors to control the air flow under different temperature conditions. While this is certainly possible, is it an entirely practical solution, especially on a large installation where several thousand vanes must be flipped each spring and fall? Has any thought been given to a thermostatic element which could adjust these vanes with respect to entering air temperature? Also, how would the large opening behind the lamp, caused by the open vane, affect the photometric performance?

(2) Fig. 3 shows a typical air temperature and velocity variation pattern through a lateral section of the test room. Since there were four troffers in the room, presumably symmetrically spaced, would this data be more representative of a section through the center of the room between troffers or a section directly through one pair of units? It would be of interest to see the same data presented for a longitudinal section through the room.

(3) The concept of "acoustical perfume" has been greeted enthusiastically by persons interested in air conditioning. Certainly it has been discouraging for diffuser manufacturers to concentrate on low noise level equipment in response to the demands of specifying engineers only to find that the ultimate user might object to the *lack* of background noise or "acoustical perfume."

Like the more familiar breeds of perfume, however, I suspect that a little bit of the "acoustical perfume" might go a long way. It would be extremely unfortunate if the concept of "acoustical perfume" became an excuse for excessive noise rather than a sound application engineering principal. For those of us who are not too familiar with noise measurement and acceptance criteria, a further explanation of Fig. 6 would be helpful. The authors mentioned that accelerated tests are being made to establish maintenance factors. Our experience has shown that the maintained performance on combination troffers compares very favorably with non-air handling units. As an example of this the maintenance figures for one typical installation might be of interest.

The combination diffusers were two- by four-foot troffers with one-half-inch plastic cube louver bottom. After over a year of operation the typical unit was removed and photometered to establish the reduction in light useable due to dirt collection. We found that based on yearly cleaning and lamp replacement at end of life, the maintenance factor would be between 75 and 80 per cent.

I hope the authors are planning a future paper to include the results of their maintenance tests. The data will be welcomed by all lighting and air conditioning engineers.

(4) Fig. 7 illustrating changes in light output for three types of diffusers compared to "static" conditions shows a dip in light output for the Type I diffuser of about 80 degrees regardless of air velocity. Is there a simple explanation for this beyond the authors' statement concerning the combination of secondary air currents and the radiating effect of cooled metal surfaces?

M. L. Quin and W. W. Kennedy:* The authors appreciate the comments and criticisms of the discussers as evidence of the many mutual and increasing interests to be found in combination units.

Mr. Archer's contribution adds to the total of knowledge becoming available, and we support his comments on the need for application information which will allow engineers to evaluate the various characteristics of these units. A common basis of comparison is vital to evaluation; however, as is generally the case, it is difficult to find in new developments. This seems to be evident in Fig. C in Mr. Archer's discussion wherein static readings were made with an 80F fixture ambient followed by relative light output readings with the fixture ambient "a normal amount greater" than an 80F room ambient. The meaning of fixture ambient is not clear. We would also ask what is a normal amount greater than the room ambient? Our experience has shown a wide variance in ceiling cavity temperatures encountered. In lieu of an accepted norm, the results shown in Fig. 7 of the paper were conducted with a standard basis for evaluation in mind. The U.L. thermal test box[1] and 25C (77F) room ambient[2] would seem to provide this standard. The room ambient also would comply with the ASA Standard for fluorescent lamps[3] and the proposed I.E.S. General Guide to Photometry. The authors do not agree that test box readings yield comparable results to relative readings from units not so confined. Test box temperatures vary with input air temperature and volume. Thus, operating conditions are affected by a changing ambient and are not directly applicable to installation conditions which vary by different circumstances. Aside from these differences, the relatively constant light output of Fig. C in the discussion is not in support of the cooling or heating effect of air passing through the lamp chamber of a troffer. Fig. 7 of the paper covers a greater test range of findings which show that light output is subject to both air temperature and volume even though separated from the lamp chamber as in Type II. Mr. Archer states that the combined unit usually will handle a greater cooling load, with a given ceiling height, if the air quantity is reduced and the temperature differential increased. This is true where the air pattern is directly downward from the unit as he has indicated in Fig. A. Other designs where there is a lateral air pattern, as would be the case with diffuser Types I and II, diffuse the air over an increasingly larger area as velocity increases. This permits the use of both higher temperature differentials and greater air volumes to handle higher loads. The octave band analysis is necessary to obtain NC numbers which are now finding wide usage with engineers in the field. We agree that an octave analysis at a high rate of flow generally reveals the shape of the curves that apply at lower flows. The shape of curves, however, is of considerable importance to the equipment designer and in application to the environment.

Mr. Harvey's observation on the difficulty in achieving a 90C maximum ballast case temperature under the test conditions imposed by U.L. is entirely true. In view of present day design trends which contribute to ballast overheating problems, the engineer will have difficulty in adjusting to a purposeful introduction of extreme conditions. Heat dissipating radiators have been successfully employed in the diffuser types shown to meet test conditions. Other possibilities include thermostatic switches to disconnect the ballast before overheating occurs. Mr. Harvey suggests that application data correlating environment, masking noise, and ballast sound ratings would be of value. The authors agree that further work should be done in this area. The combination unit provides a means for generating sounds of good quality and can be used to mask out objectionable noise and assure privacy in conversation. The authors acknowledge that Fig. 6 in the preprint was incorrectly labeled. The supply air volume was 80 cfm instead of 100

*Authors.

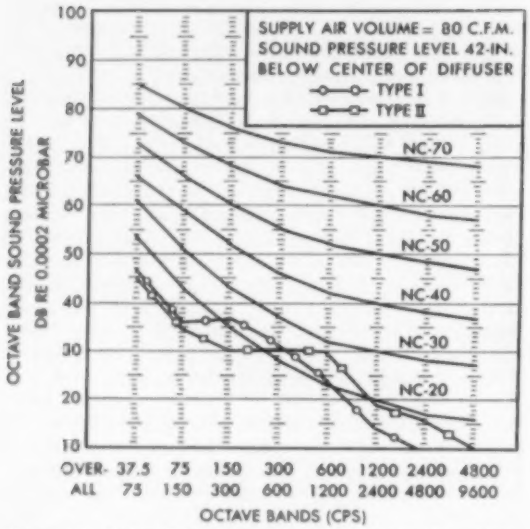

Figure H. Noise Criterion curves for supply air volume of 80 cfm.

cfm as shown. In the interest of continuity, this has been corrected in this printing by use of the proper NC curves for 100 cfm, with those for 80 cfm now shown in Fig. H.

In answer to Mr. Witte's questions concerning the adjustable vanes shown in Type I diffuser, the use of small thermally actuated bellows to automatically adjust vanes is not new. Generally, economic factors limit devices of this type to diffusers handling large volumes of air in high bay, difficult to maintain areas. In most modern office buildings, interior zones call for cooling year around, even in northern climates and under extreme conditions. The heat load produced by previously recommended levels of illumination, improved perimeter zone conditioning systems and advanced building techniques all contribute to a continuous cooling or ventilating cycle. Small installations, such as those found in suburban stores for example, would possibly benefit from seasonal adjustment. Regarding upward component losses, units tested with vanes opened and closed vary only two per cent in over-all efficiency. We attribute this to a corresponding light output increase resulting from a natural convective air flow. Induced return air flow further increases light output above the static condition, as shown in Fig. 7 of the paper. In this connection, the dip in the Type I diffuser curve at 80F to which Mr. Witte refers has no relationship with secondary air motion or metal radiation. Upon reaching the 80F, or heating cycle point, the adjustable vanes were opened allowing air to partly flow past the lamp. As air temperature increased toward optimum bulb wall temperature, light output increased also. Convective action of the air stream offset losses which would otherwise have begun at this stage. With reference to Fig. 3, the traverse shown is directly through the center of one pair of units. Longitudinal traverses have been made and show air velocities and temperatures of approximately the same magnitude. There is no excuse for excessive noise in an air distribution device and certainly no attempt should be made to justify it by calling it "acoustical perfume." The deliberate increase of noise at certain frequencies to better fit the desired NC curve is truly "acoustical perfume," or sound conditioning, and is necessary to assure proper environment conditions. Fig. 6 is a plot on noise criteria paper of the sound pressure level of the diffuser in eight octave bands at a given air volume. The sound pressure spectrum shows the "personality" or characteristic of the sound from the device. The most pleasant spectrum is one that most closely approaches the desired noise criteria. The NC curve is the result of extensive research[4] to find the most acceptable noise spectrum for various environments. These curves are finding wide usage in the air distribution industry.[5] We appreciate Mr. Witte's contribution of information on maintenance factors. From the figures reported we would assume these to be average rather than terminal maintenance factors.

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1. "Standards for Safety, Electric Lighting Fixtures," Par. 297, Underwriters' Laboratories, Inc., 8th Edition (February 1957).
2. Ibid., Par. 301.
3. "Dimensional and Electrical Characteristics, 40-watt T-12 Rapid-Start Fluorescent Lamp," ASA C78.700-1958, American Standards Association, Inc. (October 29, 1958).
4. Beranek, L. L.: "Revised Criteria for Noise in Buildings," *Noise Control* (January 1957).
5. "Sound Control," Chapter 25, *Heating, Ventilating, Air Conditioning Guide*, 1959, 37th Edition, ASHAE.

January 30—Deadline for 1960 Conference Paper Outlines

The Papers Committee of IES has set January 30, 1960, as the deadline for submittal of outlines for proposed papers for the 1960 National Technical Conference. Outlines should be mailed to:

Floyd W. Sell, Chairman, IES Papers Committee
Detroit Edison Co.
2000 Second Ave.
Detroit 26, Mich.

A.I.A. File No. 31

INSTALLATION AT WAUWATOSA, WIS.

Lighting a City Street

LIGHTING OBJECTIVE: To provide good nighttime visibility on one of a city's main traffic arteries.

GENERAL INFORMATION: This divided traffic artery has a curb-to-curb distance which varies from 60 to 100 feet. The pavement is concrete. A 480-volt multiple wiring system is used.

LIGHTING INSTALLATION: An average maintained level of illumination of approximately 1.2 footcandles is provided throughout this street project by Line Material Industries Line 2A mercury street lighting luminaires. Each luminaire is mounted at approximately 30 feet above the roadway on an American Concrete pole equipped with a six-foot bracket. Each of the luminaires is equipped with one 20,000-lumen, 400-watt H1LB/C mercury lamp and produces an IES Type IV light distribution.

The poles are arranged in both opposite and staggered arrangement, depending upon the curb-to-curb distance. Spacing for the staggered arrangement is approximately 80 to 90 feet, while for the opposite arrangement it is approximately 160 to 180 feet.

Lighting designed by F. Hoppe, Assistant City Engineer, Milwaukee, Wis.

Lighting data submitted by Louis C. Odry, Line Material Industries, Milwaukee, Wis. as an illustration of good lighting practice and to aid in the design of similar installations.

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A.I.A. File No. 31

Proposed Method of Measuring the Hiding Power of Light Shielding Materials

By WARREN O. BENJAMIN
CLARENCE W. CLARKSON

In line with the recent studies of the Illuminating Engineering Society recommending higher illumination levels has come the consideration of greater "see-ability." It is recognized that visibility increases to some extent with increased lighting levels, but only when the higher level does not produce, or increase, reflected glare. Since we see by contrast, it becomes imperative for the fixture designer to select shielding media which permit high intensities to be transmitted through the material, but still provide low brightness in the field of view, and give the best glare-free illumination at the working plane. The purpose of this paper is to define and discuss light shielding materials and their lighting characteristics, with emphasis on a proposed method of evaluating and measuring the hiding power of these materials.

Lighting shielding materials may be considered in three general categories: (a) louvering, (b) refracting, and (c) diffusing—surface treated, homogeneous or heterogeneous.

(a) Louvering: A louver has been defined as "an opaque or translucent member used to shield a source from direct view at certain angles, or to absorb unwanted light."[1] Most commonly used louvering materials are made of metal (unpainted or painted), plastic, or glass in which opal louvers are imbedded in a clear glass base. The dimensions and shape of the louver cells and the slope of the louver walls determine the shielding angle or the cut-off angle. The principal function of the louvers is to shield the lamps in the fixtures in normal seeing zones and still permit direct light to be transmitted through the louver cells. If decorative effects are desired, the cell walls may be colored.

(b) Refracting: A refractor has been defined as "a device used to redirect the luminous flux from a device, primarily by the process of refraction."[1] Primarily all refracting media are plastic or glass. Refractors may be a single prism or lens, or they may be a system of prisms that perform a specific optical function. In the commercial lighting field the prismatic function is especially desirable in refracting light away from glare zones to increase the illumination in the utilization zones. Typical applications of refracting materials are low brightness lens panels, Fresnel lenses, street lighting refractors, signal devices, projection devices, etc.

(c) Diffusing: A diffuser has been defined as "a device used to redirect the luminous flux from a device, primarily by the process of diffuse transmission."[1] Diffuse transmission is defined as "the process by which a portion of the incident flux is re-emitted from a surface or medium on the non-incident side in a non-image forming (diffused) state."[1] Basically, all diffusing media are glass or plastic. Diffusing media may be divided into three main categories: surface-treated, homogeneous, and heterogeneous. Surface-treated media are materials of which one or both surfaces are modified. Configurated or patterned surfaces may be impressed while the product is being made, or modification of the surface may be done by a second process such as ceramic coating, sanding, etching, etc. Cased diffusing materials are those having a dense white layer applied to a clear base. Homogeneous media are materials in which the diffusion is attained by homogeneous composition of the product. Pigmented materials are an example of homogeneous media, absorbing light not diffusely transmitted or reflected. Heterogeneous media are materials producing diffusion by a heterogeneous composition of the transmitting media. Opals are examples of heterogeneous media. An opal is made up of a base glass in which is suspended a heterogeneous pattern of irregular crystals having a different index of refraction than the base glass. As the light beams are intercepted by these irregularly shaped crystals, they are either refracted or reflected internally within the base glass, scattering the transmitted light. The shape and size of the crystals, and their proximity, determine the amount of scattering action and the density of the opal. The application of diffusing media is in the integration of the light source throughout the area of the panel,

A paper presented at the National Technical Conference of the Illuminating Engineering Society, September 7-11, 1959, San Francisco, Calif. AUTHORS: Corning Glass Works, Corning N. Y.

and the reduction of reflected glare. Diffusing media offer little or no brightness control.

It is possible to partially combine the performance of refracting and diffusing materials, by the addition of a small amount of opal to a crystal base product. This reduces the prismatic function slightly, but adds diffusion to give a more nearly uniform appearance.

A glass-plastic material, in which layers of glass flakes are held together with a plastic binder, produces partial polarization with some diffusion of light. Polarization is defined as "a phenomenon in which the transverse vibrations of light waves are oriented in a specific plane."[1] The effect of this partial polarization is to reduce reflected glare.

Now let us briefly discuss the lighting characteristics of light shielding materials and the definitions of their functions. For some time there has been confusion as to the method of describing these functions, and some conflict as to their meaning. One purpose of this paper is to clarify this and to establish a common basis of definition. In considering a light beam passing through a medium, the light will either be transmitted, reflected, or absorbed. The sum of the total transmittance (the ratio of the transmitted flux to the incident flux) plus the total reflectance (the ratio of the reflected flux to the incident flux) plus the total absorptance (the ratio of the absorbed flux to the incident flux) must equal 100 per cent.

Transmission has been defined as "a general term for the process by which a part of the incident flux leaves a surface or medium on a side other than the incident side."[1] Two forms of transmission are in common use: regular transmission in which a part of the re-emitted incident flux is transmitted without scattering (no diffusion), and diffuse transmission (previously defined) in which a part of the re-emitted incident flux is diffused. (The Baumgartner Reflectometer provides one method of measuring diffuse transmission.)

Reflection has been defined as "a general term for the process by which a part of incident flux leaves a surface or medium from the incident side."[1] Three forms of reflection are commonly referred to. Regular or specular reflection in "which a portion of the incident flux is re-emitted at the specular angle without scattering";[1] diffuse reflection in which a portion of the re-emitted incident flux is diffused; and compound or mixed reflection combining regular and diffuse reflection. (The Baumgartner Reflectometer provides one method of measuring diffuse reflection.)

Since the losses in light passing through a light-shielding material are the absorption (defined as "a general term for the process by which a part of the incident flux at a surface or medium is dissipated within the medium"[1]), the only useful portions are the reflected and the transmitted light. In order to evaluate the effectiveness of a material, we might consider its efficiency to be:

$$\text{Per Cent Efficiency} = \frac{\text{*Transmission Factor} + \text{*Reflection Factor}}{\text{*Transmission Factor} + \text{*Reflection Factor} + \text{Absorption Factor}} \times 100\%$$

$$\text{Or} = \frac{1.00 - \text{Absorption Factor}}{1.00} \times 100\%$$

(*Diffuse or regular as defined.)

This by no means tells us how effective the shielding medium is when used in a lighting fixture, for some of the reflected light is certain to be trapped and absorbed within the fixture. Nor would considering the transmission factor alone be a measure of the amount of light which a shielding medium would ultimately transmit because some of the light reflected back into the fixture would be further directed through the shielding medium, adding to the total amount initially transmitted. Possibly the only way to evaluate the effective or ultimate transmittance of light would be by comparing the output of a fixture having a shielding medium with the output of a fixture having no shielding medium. This might be stated:

$$\text{Per Cent Effective Transmittance} = \frac{\text{Total Fixture Output (With Shielding Medium)}}{\text{Total Fixture Output (Without Shielding Medium)}} \times 100\%$$

Again, this factor would apply only to the shielding medium used in a specific fixture or a specific class of fixtures. (Earlier studies defined this measurement as "efficiency," and even went to the extent of suggesting that "if the lamp and box are standardized as to shape, dimensions, reflection factor, etc., the arbitrary results can be made substantially standard."[2])

Up to this point we have discussed the basic types of light shielding materials and the characteristics by which they are commonly compared to each other today. They are all useful for consideration of illumination, but do not take into account "see-ability" or comfort.

Comfort and "see-ability" are of utmost importance in considering a lighting installation, particularly if people will be working at detailed tasks. There has been a considerable amount of research and investigation done on the evaluation of direct glare from luminaires and its effect on visual comfort. These have been evaluated primarily through a Glare Factor System and Visual Comfort Index

rating system, but no consideration of reflected glare is included in either system. Reflected glare may cause greater discomfort and reduce "see-ability" more than direct glare, since reflected glare is experienced nearer the center of the field of view, rather than near its periphery as in the case of direct glare. We know that the discomfort caused by direct glare from a luminaire is proportional to the square of the brightness of the luminaire; its closeness to the normal line of sight, both vertically and horizontally; the closeness of the luminaire to the viewer; the brightness contrast between the luminaire and its immediate surround; and the brightness contrast between the luminaire and the background (walls). The discomfort resulting from a reflected glare source is dependent on the same conditions as that from a direct glare source. However, the situation is magnified, since the source of glare is now nearer the normal line of sight.

The direct glare rating systems do not differentiate between luminaires on the basis of uniformity of brightness. There is a difference in the amount of discomfort due to direct glare from a uniformly bright panel versus one having bright and dark streaks, or intermittent bright and dark areas. The difference can be ignored, though, since the distances involved make the effect of this variation slight in comparison with the other factors already mentioned. Such is not the case when reflected glare is considered. The source of glare is usually very close to the eye so that a reflected image of a luminaire fills a large part of the field of view. Obviously, the best solution to the reflected glare problem is to remove all objects having a specular finish from the field of view where an image of the light source may be mirrored. The next most effective solution is to control the finish on objects within the field of view so that there is no intense, concentrated, reflected component of light from them. Satin-finish colors will accomplish this. We also know from past studies that discomfort can be kept to a minimum, and "see-ability" at a maximum, by close control of brightness and color contrasts in the field of view. Dr. H. Richard Blackwell, while at the University of Michigan, made a very intensive and conclusive study[3] of the effect of contrast versus brightness on "see-ability." His findings were used as the basis for the 1958 "I.E.S. Recommended Illumination Levels" which are so well known today. The consideration of reflected glare sources in the field of view is being studied in other researeh, now underway.

One of the prime factors in the consideration of reflected glare, as mentioned above, is that of brightness contrast. This contrast is not necessarily only between adjacent surfaces as we normally think of it, but also on any given surface. For example, everyone has at one time or another sat before a glass-topped desk and squinted at his work because there was the image of a very bright incandescent lamp, or possibly of some bare fluorescent lamps, reflecting from the glass into his eyes from an area very close to his task. This is an extreme situation, but illustrates the problem at hand quite clearly. If it were necessary to maintain this objectionable desk surface, the discomfort and disability due to reflected glare could be minimzed by creating a light source of an infinitely large area with a uniformly lower brightness, but still maintaining the same general lighting level on the task. By doing this, the brightness contrast is immediately lowered. Obviously, then, a small, compact, very intense source is one extreme, and an infinite source of uniform brightness is the other extreme in their contribution to discomfort due to reflected glare. Although this is only one facet of the problem, it must be investigated as to a method of evaluating non-uniformity of brightness of a panel, and also how to measure it.

This problem was recognized as far back as 1932 when a Progress Report was submitted to the Twenty-sixth Annual Convention of the Illuminating Engineering Society by the Joint Committee on Illuminating Glasses. The report mentions that some glasses may exhibit the same amount of diffusion, but have entirely different obscuring power (hiding power). That distinction is made in the way diffusion and obscuring power measurements are made. Measurement of diffusion is "essentially a distribution curve of brightness, or the light emerging from the glass (lighting panel) over a certain restricted area illuminated by a concentrated light source."[2] Since 1932 other media besides glass have made their way into the lighting field. Their measurements are made the same way, however. A narrow field photometer is used to measure the brightness in an arc about some fixed point. The resultant data are usually shown in graph form.

If a wide beam is substituted for the narrow incident beam used in diffusion photometry, the light striking the shielding material in the center is spread out (diffused), but not necessarily as much as the angular width of the original beam. The source is obscured by this function, and the maximum brightness is reduced. The light near the extremities of the wide beam is diffused, widening the beam, and also grading the brightness of the shielding material rather than allowing an abrupt change in brightness. Basically, then, the obscuring power, or hiding power, of a shielding material is a function of the brightness gradient across the panel.

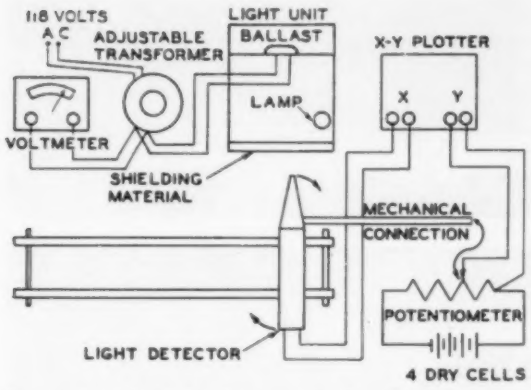

Figure 1. Schematic diagram of laboratory apparatus for measuring brightness gradients.

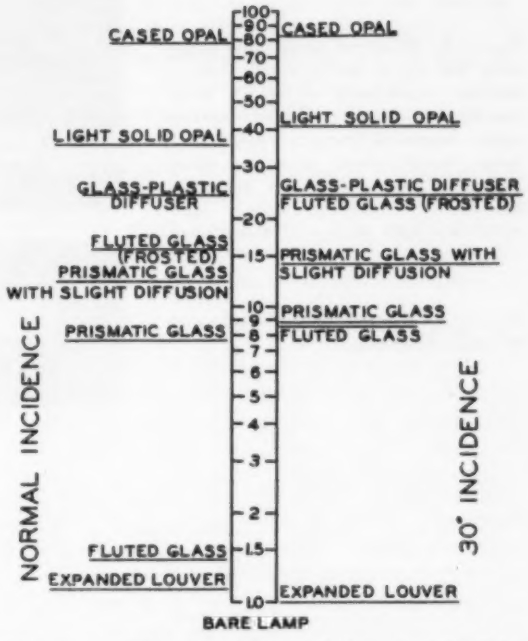

Figure 2. OPF scale showing relation of eight light-shielding materials at 0 and 30 degrees incidence.

Hiding Power (Obscuring Power) may be defined as the effectiveness of a shielding material to obscure the outline of the light source. The gradient is magnified in flat products having a good reflecting rear, or upper, surface. As the angle of incidence from the light source increases on the rear of the panel, particularly if it approaches 40 degrees or more from normal, the percentage of light reflected from, rather than refracted into, the material increases very rapidly, causing a decrease in transmitted light, and consequently in brightness. The decrease is helped further by the fact that as the angle of incidence increases, any given solid angle of light is distributed over a larger area of the panel, decreasing the amount of light per unit area according to the cosine law. Illuminating engineers have various ways of comparing shielding media; that is, by transmittance of several types, color, reflectance, effective transmittance, efficiency, etc. None of these can be used to compare hiding power of the materials. The writers have undertaken the task, and wish to propose an evaluation system of hiding power, or obscuring power.

In the foregoing discussion it was stated that hiding power is a function of the gradient of brightness across a panel. The ideal shielding material would "hide" the source to such an extent that the whole surface would have uniform brightness to combat reflected glare, as would be approached with an extremely good diffuser, and still have good high-angle brightness control to combat direct glare. Such a material is not to be had at present, and those on the market will have variations in brightness. Obviously, if the gradient is uniform, it will be less offensive in its effect on sources of reflected glare, as well as in appearance. The extreme opposite of a perfect diffuser would be polished clear glass.

Recognizing this, we felt that a limiting factor, then, was the maximum rate of change of brightness across any shielding material. To investigate this, we established that the fluorescent lamp should be used as a source, since its use is increasing and hiding power is usually discussed with regard to it. Also, hiding power and brightness control will soon be of utmost importance with high-output fluorescent lamps, as the new higher, recommended foot-candle levels gain wider acceptance. Next, we established that the worst possible condition would be to have a lamp directly against the back of the shielding material, with a flat black background. A lamp was placed vertically in a box. Samples of

TABLE I — Brightness Gradient Normal to Sample (In Candles Per Square Inch Per Inch).

Sample Type	Lamp Center 1¾" Behind Sample		Lamp Center 2¾" Behind Sample	
	Flat Black Backing	White Enamel Backing	Flat Black Backing	White Enamel Backing
Cased Opal	.34	.39	.16	.24
Light Solid Opal	.60	.70	.35	.40
Fluted Glass, Frosted*	1.13	1.10	.80	.96
Glass-Plastic Diffuser	1.20	1.33	.98	1.04
Prismatic Glass With Slight Diffusion**	2.60	2.16	1.55	1.49
Prismatic Glass**	3.59	2.41	1.65	1.85
Fluted Glass*	8.58	2.66	9.15	2.50
Expanded Louver	8.58	5.95	11.45	7.62
Bare Lamp	12.49	7.22		

*Same pattern on these two samples.
**Not the same prismatic pattern.

Figure 3. Photo of fluorescent lamp with flat black background, demonstrating appearance of OPF's from Fig. 2, with 0 degree incidence. Left to right: expanded louver material, bare lamp, fluted glass, prismatic glass, prismatic glass with slight diffusion, glass-plastic diffuser, fluted glass (frosted), light solid opal, cased opal.

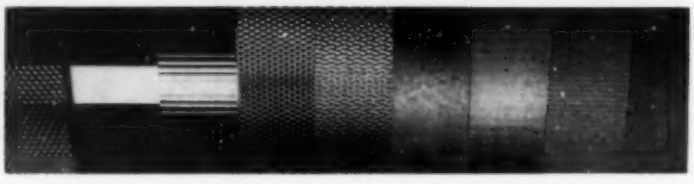

Figure 4. Same as Fig. 3, but with 30 degrees incidence.

materials to be tested were of such a length that there was an opening above and below the samples to allow constant air circulation past the lamp at all times, thus avoiding light output variation during the tests due to heat variation. A 20-watt, 24T12 standard cool white lamp was used as the test source, having a rated output of 1000 lumens.

Measurements of brightness were taken with a 24-inch long rectangular black tube containing a barrier-layer type cell. The aperture was ¼ by 4 inches, with the 4-inch dimension parallel to the lamp axis. A narrower aperture showed insignificant ripples in the brightness curve. A ½-inch by 2-inch aperture produced slightly smoother curves but no difference in results. An X-Y plotter was used to record the information. The light cell was connected to the Y-scale which had a sensitivity of 200,000 ohms per volt, a full-scale current drain of 5 microamperes, a range of 5 millivolts and an accuracy of 0.25 per cent of full scale. The X-scale had a sensitivity of 200,000 ohms per volt, a full-scale current drain of 5 microamperes, a range of 1 volt, and an accuracy of 0.25 per cent of full scale. The voltage from four dry cells was supplied through a slide-wire potentiometer. The light cell tube was connected physically to the slide on the potentiometer so that when the cell was scanned across the shielding material, the voltage was automatically varied to indicate the movement of the cell directly in inches. The Y-scale was calibrated in candles per square inch, according to the practice recommended by the Illuminating Engineering Society for making brightness measurements. Merely by moving the light cell and potentiometer slide and scanning the panel, we were able to obtain in a few seconds a graph of brightness in candles per square inch versus distance across the panel in inches, plotted on standard 8½- x 11-inch graph paper. Results from various samplings showed too little difference with the lamp against the shielding material, so the first complete group was run with the lamp center 1¾ inches behind the panels. Twenty-three samples were tested, including several prismatic, brightness-controlling media, both in glass and plastic; a solid opal glass; a cased opal glass; frosted glass; an expanded louver material; and a glass-plastic diffuser. They were tested for the maximum brightness, as compared to that of the bare lamp; the distance across the panel to where brightness was decreased to fifty per cent of maximum; and the maximum slope of the brightness curve, which indicates the fastest rate at which the brightness is varying on any given panel.

Results of these tests showed that in general, most prismatic pieces tested fell in a group having relatively steep slopes and high maximum brightnesses, depending on the type of pattern. The diffusing materials had generally more gradual slopes and lower maximum brightnesses, depending on the thickness and relative amounts and types of diffusing ingredients used.

Eight samples were chosen as representative of the twenty-three, to limit the amount of further data to be collected. These were tested with the lamp center 2¾ inches from the sample, as well as 1¾ inches, with the cell box normal to the panels; with the cell box thirty degrees to normal; with the cell box sixty degrees to normal; and repeated with a white enamel background substituted for the flat black background. The results of these tests are shown in Table I. A comparison of the actual brightness gradients of the samples shows that the sample having the smaller number value has the better hiding power. Conversely, a higher number represents a poorer hiding power. This inverse relationship, we feel, would have an adverse effect on the acceptability of such a rating system. Also, the object of the investigation was to derive a system of

evaluation that would tell us that the hiding power of a material was some number of times better than a bare lamp. Since the brightness gradients were all smaller than that of the bare lamp, and their numerical values decreased as the hiding power improved, the logical comparison would involve the brightness gradient as a denominator of some relationship. The Hiding Power Factors shown in Fig. 2 are the ratio of the maximum rate of brightness change with the bare fluorescent lamp to the maximum rate of brightness change across the sample. The Hiding Power Factor (Obscuring Power Factor—OPF) may be defined, then, as the ratio of the maximum gradient of brightness of a bare light source to the maximum gradient of brightness of a material shielding the same source. These results shown were taken from tests with a flat black background and with the lamp center 2¾ inches behind the sample. Thirty degrees was selected as a representative angle, being two-thirds of the way from normal to the outer limit of the commonly referred to "reflected glare zone" (0-45 degrees), to show that the hiding power of some materials changes as the angle of incidence changes. This could conceivably be of importance if those working on the reflected glare problem find that reflected glare is more offensive at one angle than at another. The fact that the upper limit of OPF in Fig. 2 is 100 does not imply that 100 is a maximum that can be achieved.

Fig. 3 is a photograph of the eight selected samples arranged in the order of their respective OPF, except that the expanded louver material and the bare lamp are reversed, as they are in Fig. 4. It is quite evident that as the OPF decreases, the apparent width of the light source decreases, the maximum brightness increases, and the gradation from the area of maximum to minimum brightness is definitely more pronounced. Fig. 4 shows that the effect is different when the angle of incidence changes. However, the trend is still the same, as shown by Fig. 3.

The OPF's shown in this paper support the results of visual comparisons of the test samples made in the test laboratory. This investigation should have significance in the study of reflected glare. Further study may show that it would be advantageous to use this information in some other form, or to extend the investigation. In either case, the approach described above should be useful.

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Integrated Lighting - Air Conditioning Systems

(Discussion and rebuttal of a paper by W. S. Fisher and J. E. Flynn, published in October ILLUMINATING ENGINEERING)

J. S. HAMEL:* Mr. Fisher and Mr. Flynn have brought to the foreground a very important phase of lighting. While this paper does not deal directly with illumination, it deals most directly with the side effects of the trend in illumination which is affecting the cost of structures today. It is most difficult for many architects and owners to understand and appreciate the side effects of higher levels of illumination on air conditioned structures and the fact that something can be done to reduce the costs of these side effects.

The authors are to be congratulated on exploring the technical and practical aspects of integrating lighting and air conditioning systems to a degree where one system will help the other rather than penalize it. From a critical standpoint, I have some question in my mind as to the economics of integrating lighting as a heat source for heating the building. It appears to me that this could be an expensive method of heating the building. I believe that the application of heat gain from lighting should only go so far as to utilize the supplementary effect of heat gain from lighting. It seems impractical that lighting systems would be operated to supply heat to buildings. The boiler plant and the necessary piping radiation, etc., must be sized, irrespective of whether lights are used or not. It is recognized that there are many Btu's in lighting which can be utilized to supplement Btu's which normally might have to be generated by means of radiators or fan and coil units and supplied heat vin steam or hot water boilers. However, I believe it will be found that the Btu's generated by means of lighting will be much more costly than those which can be generated by means of natural gas or fuel oil.

*Consulting Engineer, Burbank, Calif.

Another comment is on the author's reference to using water as a cooling media for luminaires. I do not question that it could be done, however, we have enough problems with integration of trades, without having plumbers to consider in addition to electricians, carpenters and sheet metal men who can complicate construction with jurisdictional disputes.

I believe that air conditioning engineers will disagree somewhat in their reaction to the various percentages and figures brought out in this paper. However, irrespective of differences of opinion, it is most important that consideration be given to the removal of the heat from the luminaire, before it gets into the space, so that the integration of these two systems can result in a definite saving in air conditioning costs. It is this fundamental consideration that is the most important part of this entire paper, in my opinion. Whether or not 60 per cent, 40 per cent or even 20 per cent is saved, a definite reduction in costs of air conditioning systems will serve to justify better systems of illumination and serve to provide more comfortable interiors.

To site an example in connection with a certain large structure, built in the southwest during the last year, a load of 186 kilowatts of incandescent lighting in the ceiling system was reduced approximately one-third, insofar as its contribution to the lighting system is concerned, by means of ventilating air through the luminaires and removing the radiant heat of the fixture and the heat generated by the incandescent lamp before it entered the air conditioned space. The only heat from the lighting source reaching the air conditioned space, was the reflected radiant light through the reflector system, and the direct flux from the lamp through the ceiling aperture. This example represented savings of about 20 tons in refrigeration.

M. L. QUIN:* Though not as all-inclusive as the title would indicate, this paper does present tangible evidence of dividends to be realized from ventilated lighting systems.

Benesch[1] has shown that as illumination levels increase, temperature differentials above 25 degrees and/or air changes above 20 per hour are difficult to handle with "all-air" systems. Leopold and, more recently, Spiegel[2] have shown the efficiency of water-cooling as a transfer means for the lighting heat load. Perhaps, large scale 500-footcandle installations will ultimately utilize a combination of the systems illustrated in Figs. 6 and 7 in conjunction with both radiant panel and air cooling systems as Benesch suggests.

The initial distribution of heat energy by the troffer in Fig. 3 is extremely interesting. More data are needed on the normal distribution of specific luminaire types after heat build up. Tests have shown, for example, that as much as 60 per cent of the total heat energy produced by a two-by four-foot glass-enclosed troffer is transmitted into the conditioned space. With the application of higher loaded lamps to conditioned spaces, information of this type will be extremely valuable in the evaluation of heat transfer systems.

A more difficult, yet necessary, factor in system evaluation will be that of maintenance. Room air ventilated through troffers, particularly enclosed types which trap dirt in the lamp compartment, can lead to increased maintenance unless careful consideration is given to air flow paths. Investigations in the direction of the work by Taylor and Bradley[3] will be very helpful.

The current Underwriters' Laboratories Standard for Electric Lighting Fixtures does not provide for construction allowing flush-mounted troffers to handle air flow. Appended paragraphs to the Standard which cover air supply functioning are near release, however, investigation of the exhaust function has been continued. At this writing, a detailed report is being prepared for submission to the U. L. Electrical and Fire Councils. Among the conditions being considered are possible hazards resulting from explosive fumes of malfunctioning ballasts or fire from any combustible luminaire component being drawn into duct systems.

In the writer's opinion, conditions which may lead to hazardous failure would be extremely difficult to duplicate in a plenum of moving air. The use of combustible materials, such as plastic louvers or enclosure panels will quite possibly be limited to types which supply rather than exhaust air.

*Day-Brite Lighting Inc., St. Louis, Mo.

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W. S. FISHER AND J. E. FLYNN:* We appreciate very much the comments of Mr. Hamel and his reference to the large building in which he achieved some integration of the lighting and air conditioning. Reduced air conditionng tonnage and lower air volumes are strong incentives for controlling lighting heat.

With regard to Mr. Hamel's point on the heating of buildings, we agree that the Btu/hour from light sources may not always represent the most economical method of *heating*. However, modern illumination (which may represent 20 Btu/hour/square foot, or more) is desirable in itself for reasons of visibility and human visual performance—and the lighting user gets a bonus if he capitalizes on the heating properties. We know of a store where the boiler capacity was halved when the management realized the potential lighting afforded as a heat source. We understand that an office building is now under construction in which the lighting is also planned to be the principal heat source. When heating is needed a thermostat will automatically turn on the building lighting, whatever the time of day or night.

Mr. Quin's remarks are appreciated because of his experience in the design of luminaires for air distribution. Such units might be adapted to the concept of lighting heat control covered in this paper without a great deal of modification. We are glad to have his "progress report" on the subject of investigations by the Underwriters' Laboratory of troffers which handle air flow.

On the subject of maintenance of troffers which handle air, we have operated the experimental system described in the paper for about one year and find that dirt collection has been negligible. Maintenance should not inhibit the application of integrated lighting-air conditioning systems of this type.

*Authors

INSTALLATION AT BRITISH COLUMBIA ELECTRIC CO., LTD. BUILDING, VANCOUVER, B. C

Lighting a General Office

LIGHTING OBJECTIVE: To provide comfortable general illumination for regular office work.

GENERAL INFORMATION: The general office shown above measures approximately 20 feet by 60 feet. The ceiling height (to bottom of luminous ceiling) is 9 feet. Walls are turquoise, beige and gray (35 to 50 per cent reflectance); the floor is mottled cream and tan (35 per cent reflectance); the desk tops are light gray (57 per cent reflectance) and the shades are light gray (40 per cent reflectance). The 12- by 12-inch reinforced concrete beams shown in Fig. 2 are on 10-foot centers, dividing the ceiling into standard bays 10 feet wide by 15 feet long.

INSTALLATION: In order to provide a lighting system which would allow the installation of floor to ceiling partitions on three-foot four-inch centers to match the general module of the building and to cover effectively beams, pipes and air-conditioning ducts, a special luminous ceiling was designed by Lighting Materials, Ltd., Winnipeg, Man. This luminous ceiling, as shown in section in Fig. 2, consists of single-lamp channels mounted on the concrete ceiling and vinyl plastic reflecting and diffusing elements (Fig. 3) suspended 16 inches below the concrete ceiling on extruded aluminum channels. The channels are approximately 15 feet long. Each is equipped with four 40-watt T-12 warm white rapid start fluorescent lamps

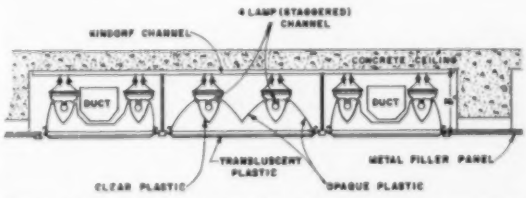

Figure 2. Section through the ceiling showing mounting of luminaire.

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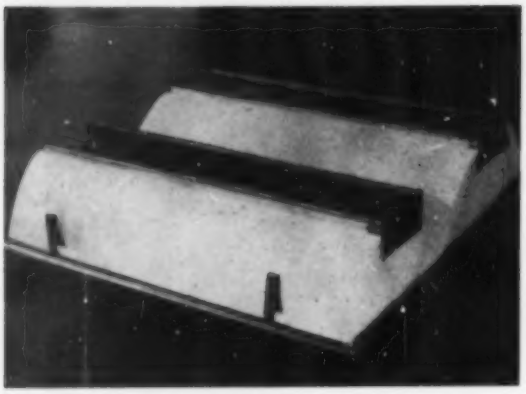

Figure 3. Typical reflecting-diffusing element.

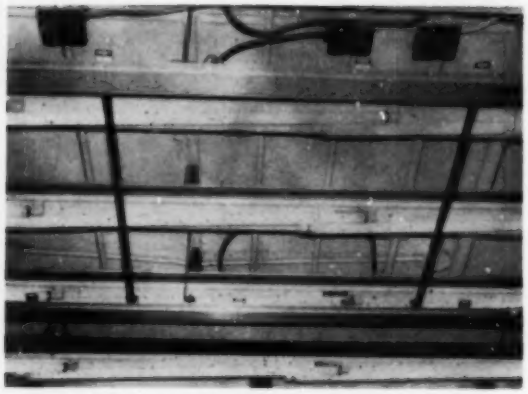

Figure 4. View of ceiling with plastic elements removed.

angled and overlapped, as shown in Fig. 4, to prevent dark areas under lamp holders. The use of a sealed-in reflector-diffuser design eliminates the need for cleaning or repainting the plenum.

After about eight months operation the average level of illumination was 104 footcandles (group relamping is done at ten-month intervals). Brightnesses were as follows:

ceiling		walls	
luminous portions (highest)	243 fL	above window	42 fL
metal filler panel	25 fL	between windows	32 fL
		floor	53 fL

Lighting designed by M. A. Thomas and Associates, Vancouver, B. C.; Architect: Sharp, Thompson, Berwick, Pratt, Vancouver, B. C.

Lighting data submitted by D. S. Gordon, Lighting Specialist, British Columbia Electric Co., Ltd., as an illustration of good lighting practice and to aid in the design of similar installations.

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A New Method for Studying
Effects of Direct Sunlight on Building Interiors and Subsequent Skylight Studies

By BEN H. EVANS
MATTHEW NOWAK

THE FEASIBILITY of using models for the study of natural lighting has been well established by researchers, the world around, in the past 25 years. Models of buildings have been studied under natural skies and under simulated skies. No less than 25 simulated skydomes located in all parts of the world have been used for these studies. That such studies can be simple, comprehensive, and accurate is a well-established fact.

However, for the most part, these model studies have been limited to cloudy and overcast sky conditions because of the complicity of studying with both a simulated sky and simulated sun. Studies of building illumination for an overcast sky have been valuable but obviously not comprehensive enough to satisfy man's interest in interior daylighting.

Many attempts have been made to study the effects of direct sunshine by conducting tests on full-scale buildings, but this is not satisfactory as a system for predetermining daylighting conditions. Studies have been made with models under direct sunshine and often this method has provided good results, but the uncertainty of the weather, the fast-moving sun, and the changeability of other environmental factors makes this type of study tedious, time consuming and often inaccurate. These disadvantages can be eliminated by conducting model studies under controlled conditions such as has been done with simulated skies.

P. Petherbridge, at the Building Research Station in England, and W. S. Griffith, at Southern Methodist University in Dallas, have both conducted studies of direct sunshine with the aid of electric lamps. However, neither of these studies was intended as a method for studying all phases of direct sunlighting. Many calculation devices and formulas are available for estimating the effects of direct sunshine, but these seldom have really provided any significant information other than shadow patterns and critical sun angles.

A paper presented at the National Technical Conference of the Illuminating Engineering Society, September 7-11, 1959, San Francisco, Calif. AUTHORS: Texas Engineering Experiment Station, College Station, Texas. Accepted by the Papers Committee as a Transaction of I.E.S.

Obviously, if architects and lighting engineers are to be well enough informed to consider all aspects of natural lighting in the design of buildings, there must be a comprehensive and satisfactory method for studying all phases of natural lighting, including direct sunshine. The purpose of this paper is to describe the development of such a method.

The New Method

The new method involves the use of scale models with a simulated sky and simulated sun. The simulated sky is a flattened hemispherical dome, illuminated by 150-watt incandescent flood lamps suspended in a trough around the base of the dome. This is the same dome that has been in service at the Texas Engineering Experiment Station since 1955, succeeding another dome developed in 1950, and has proven very effective in studying models under all types of skies, excluding the direct sun itself. Brightnesses in the dome can be adjusted to simulate any desired sky brightness pattern by ad-

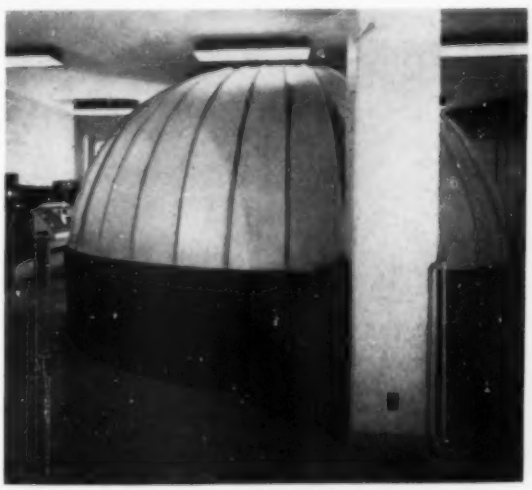

Figure 1. Simulated sky dome.

Figure 2. The electric sun lamp and terrain table.

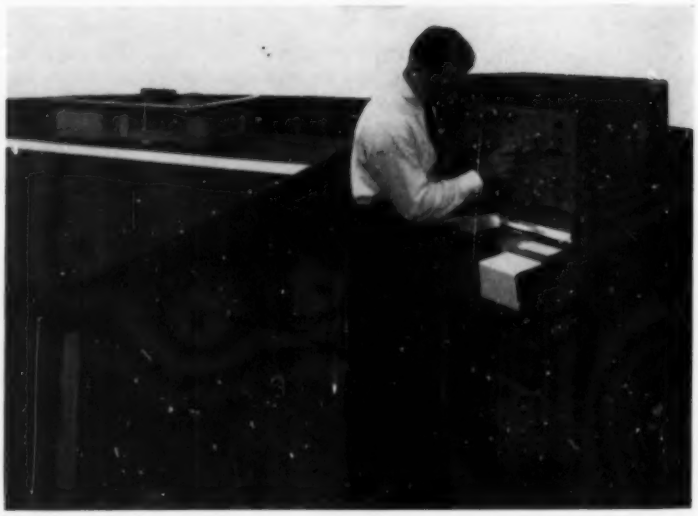

Figure 3. The electronic amplifier and recorder being used to test a model in the simulated sky dome.

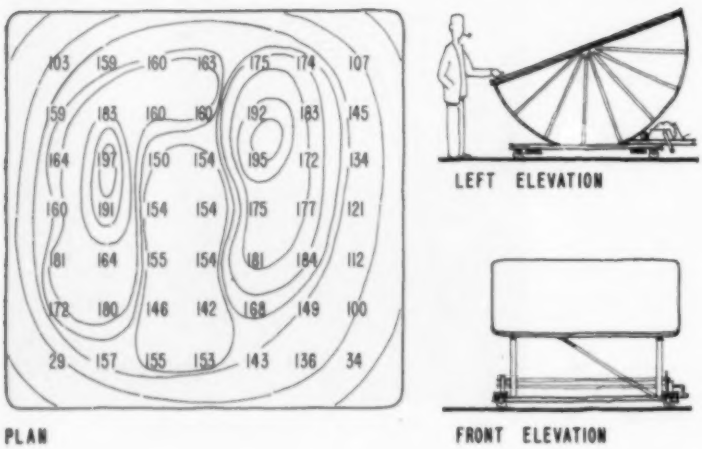

Figure 4. Diagram of the terrain table showing levels resulting from use of the sun lamp. Surface at 70 degrees.

justing the incandescent lamps and/or by adding additional lamps.

The simulated sun consists of an easily portable incandescent 5000-watt spot lamp which is used in conjunction with an 8-foot-square terrain table. The lamp is used at a distance of 20 to 40 feet from the terrain table, depending on the area of light desired on the table top and the desirable foot-candle level.

Because of limited laboratory space and ceiling height the sun lamp is used in a horizontal position, projecting its light laterally across the laboratory to the terrain table. The table is constructed so as to adjust to provide any sun angle desired and surface reflectance is provided to represent whatever conditions are involved in the full scale counterpart.

To eliminate stray and reflected light which would affect the model test results, the area around the terrain table is screened with heavy black curtains and ceiling baffles. Of course, the laboratory is otherwise darkened as much as is possible during the tests.

Again, because of the physical and economic limitations of the laboratory room, the sun lamp and sky dome are not used simultaneously. Tests on any given model are first conducted in the lighting dome and secondly on the terrain table under the sun lamp. The results of these two separate tests are then related by calculation to full scale conditions and added together for the final results.

To control the variation in current for the simulated sky, sun, and other instruments, a regulating transformer is used. This assures that conditions for the model tests remain as constant as possible. Illumination readings are made with Weston Photronic barrier layer photocells, with cosine corrector, and Viscor filter. These cells are used in conjunction with a low-level, pre-amplifier, and oscillograph recorder which allows quite low intensities to be measured accurately. Brightness measurements are made with a Spectra Brightness Spot Meter.

Additional supplementary equipment such as standard lamps, photometer for calibrating cells, reflectometer for measuring reflection and transmission factors, and complete shop facilities for preparing models and equipment, are also employed in these studies.

Performance of Sun Lamp

Since the performance of simulated skies, and the one at the Texas Engineering Experiment Station in particular, have been shown in previous publications, this paper will not attempt to reiterate these findings, but will instead concentrate on the details of the new simulated sun.

The sun lamp is a 110-volt, 5000-watt incandescent spot lamp of a commercial type readily available on the open market. It has complete control for focus, shutter, angle, and size and shape of spot. It is mounted on wheels and has a counterbalanced height adjustment. Near parallel light rays are produced with the aid of a built-in parabolic reflector and a Fresnel lens.

At a distance of 40 feet it produces an illumination pattern on the terrain table top as indicated in Fig. 4. While the pattern is not entirely uniform over the table surface, it has been found to be sufficiently uniform to produce satisfactory results. The introduction of further controls on this particular lamp for the purpose of smoothing out the pattern reduces the surface illumination to such an extent as to render the alteration of no value. The angle of the table top, of course, has a great deal to do with the illumination pattern on the table top, as does the distance of the lamp from the table. In each case, however, the pattern is uniform enough for the studies performed to date.

The first studies performed under the new sun lamp were on a model of the Texas Engineering Experiment Station's 30-foot-square experimental building. This building was constructed in 1950 for the primary purpose of studying light, air, and sound. It is mounted on wheels which ride a circular track to allow any desired orientation. Since the building is located on relatively open, flat terrain, there are no obstacles to unduly influence tests performed here. The building is constructed so that the roof shape and height may be varied and the walls easily converted from one type of construction to another.

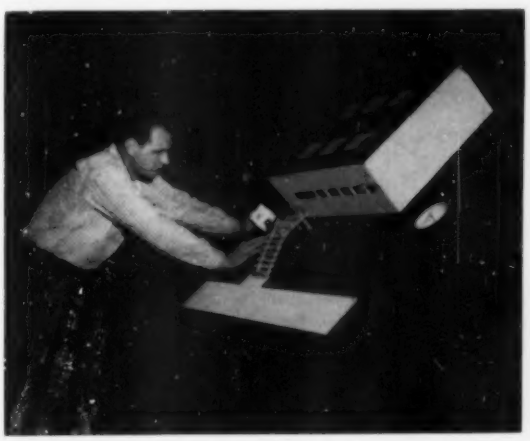

Figure 5. Terrain table with model and sun-angle measuring devices.

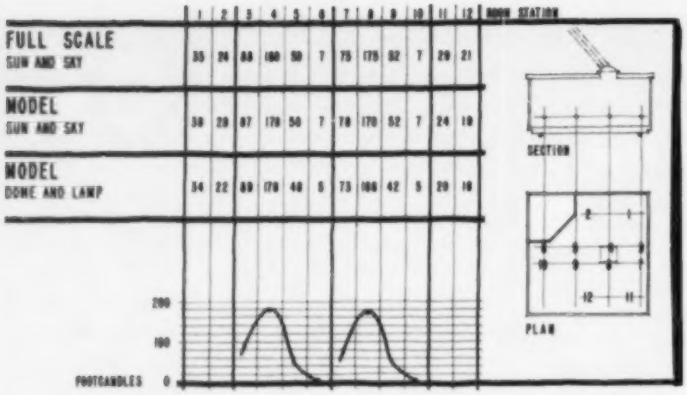

Figure 6. Levels resulting from tests on the experimental building and a scale model.

For purposes of this test and further studies on skylights, the walls, floor, and ceiling were blacked out to minimize surface reflections. A 52-inch-square plastic dome skylight was installed in the ceiling and the building oriented in a north-south direction.

The results of illumination measurements under a clear sky with sunshine are indicated in Fig. 6. Illumination readings are shown on the top line of the chart for the 12 points in the building which are indicated on the plan view to the right of the chart.

The second line shows the illumination readings inside a scale model of the experimental building which was tested at the site of the full-scale tests. It was tested concurrently with the full-scale tests, under the same sky conditions. The third line of the chart indicates levels inside the scale model after being subjected to the simulated sky and sun in the laboratory and the results related by calculation to full-scale conditions.

Most of the illumination readings taken inside the model with the simulated sky and sun are within an average of 13 per cent of actual values. The per cent error is greatest at the points of very low illumination, partly due to the inherent difficulty of measuring such low levels with field instruments.

Fig. 7 indicates the results of tests on a typical school building classroom model which was tested both in the laboratory and in the field. The first line on the chart shows levels at the room points indicated, with actual sun and clear sky. The second line indicates levels in the model when tested under the simulated sky and sun and related to full-scale conditions. Naturally, there is a large component of sunlight reflected from the ground, which provides a good indication of the value of the electric sun lamp. Note that levels for actual sun and sky and for the simulated sky dome and sun lamp are very close. The average error is less than 8 per cent.

In order to estabilsh further the value of model studies with the sun lamp, a model of another typical classroom was constructed. This model included three four-inch-square, specially blown acrylic plastic dome skylights located toward the rear of the room. The model also had a fenestration of typical construction with no blinds or sun controls. The model was first tested in the field under a clear sky with direct sunshine and with the fenestration facing to the north. It was then tested under the simulated sky in the laboratory using a standard clear sky brightness distribution. Next the model was moved to the terrain table and tested under the sun lamp with the laboratory blacked out. Results of

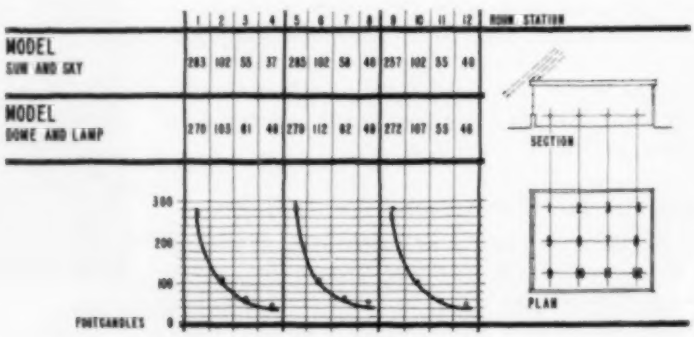

Figure 7. Levels resulting from a study of fenestration light inside a model room.

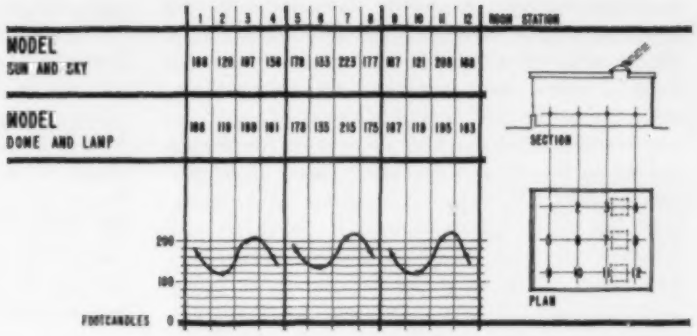

Figure 8. Levels resulting from a study of a model with skylights.

the tests under the simulated sky and sun lamp were then related to actual full scale sky conditions and added together to provide the final results.

Fig. 8 shows the resulting illumination levels when this model was tested under actual sun and clear sky (top line of the chart), and under the simulated sky dome and sun lamp (second line of chart. The average error is less than 2 per cent and the maximum error only slightly over 6 per cent.

The accuracy of these results to date indicates the real feasibility of performing studies with the laboratory equipment described here. To further ascertain the performance characteristics of the equipment, brightness measurements were made on the model plastic dome skylights under the sun lamp and on the models and their full-scale counterpart skylights tested under the actual sun.

First readings indicated that the angle of measurement and other instrument conditions were so critical that a mechanical stand had to be constructed that would allow identical measurements to be taken inside and outside the laboratory. Fig. 9 shows the testing equipment in operation.

There is very good correlation between the model domes and the full-scale domes tested under the actual sky. However, readings taken with the electric sun lamp are somewhat erratic, especially with the plastic domes of high transmission. It would seem that because of the uneven light distribution of the sun lamp it would be very difficult to obtain accurate brightness readings looking through the material directly into the lamp, particularly with the high transmission domes which do not diffuse light sufficiently. A thin diffusing material placed over the sun lamp lens eliminates this problem, for reading brightnesses of skylights and other diffusing materials.

Skylight Studies

In past years as the problems involved in designing for good lighting have become more familiar, more and more complicated control devices have been developed to accomplish desirable lighting conditions in our buildings. Hanging louvers, plastic louver walls, glass prisms, reflectors, diffused glazing materials, and many other such controls,

Figure 9. Skylight brightness studying equipment in use out-of-doors.

sometimes movable, sometimes fixed, have become problems in practical, economic architecture. In what would seem somewhat of a revolt toward this trend of design, many architects across the country are going to the roof for light instead of using the fenestration, which has been the custom for so long and which usually is the primary cause of brightness troubles. With the increased use of skylights, there has been a great demand for complete and accurate information concerning their proper use. As a result of this need and because of the subsequent development of the sun lamp, the Texas Engineering Experiment Station has been conducting an extensive study of skylights and their proper use.

By eliminating the "vision strip" (that strip of fenestration which is transparent and used for seeing outdoors), the high brightness values usually associated with the sky and sunlit surroundings are eliminated from view, leaving the lighting fixtures, skylights or other such interior bright spots as the points of maximum brightness.

History and experience, backed by lighting research, show that skylights can and have been very effectively used in lighting interior for many years. Skylights are now new to architecture. Even the Egyptians used "roof holes" and clerestories for interior lighting thousands of years ago and the American Indian always maintained a hole in the top of his tent for light and air movement. But only recently have skylights been designed and prefabricated for really easy, economical and waterproof installations. Postwar economic stresses on school buildings and the demand for plenty of good natural light have stimulated the development of skylights more than has anything else. New methods and the availability of new materials finally brought about the production of simple, economic roof lights.

For the most part we have not used this new tool to complete advantage. Foster Sampson, the West Coast lighting expert, once reasoned this way: "It really doesn't make much sense to get our light through windows in the vertical wall as we have been doing for so long. If illuminating engineers in designing their general lighting systems put all their lighting fixtures on one wall, they would be laughed out of business. Overhead seems the more logical place for sources of general illumination."

Quite early in the modern history of skylights the problem of controlling the brightness of the skylight material itself arose as a significant factor. Clear materials have always been objectionable, where good seeing conditions were desired, because of the beams of direct sunshine that are allowed to pass through. These bright spots inside the building provide high contrasts which are fatiguing to eyes and sometimes nearly "blinding." Thus, the "frosted" or translucent skylight material was developed in order to diffuse the incoming light and eliminate the bright spots of sunshine.

This introduced another problem. The translucent material in the skylights was often excessively bright when exposed to direct sun, again causing eye strain. The skylight material can be of such a nature that its brightness will not be an annoying factor, but this requires that it be of a very low transmittance material, usually below 15 per cent, in which case there is often not enough light passing through the opening to illuminate the inside of the building sufficiently.

To shield the excessively bright skylight from view and still allow plenty of light, every conceivable kind of device has been used: louvers, shades, suspended ceilings, eggcrates, and finally even another layer of translucent diffusing material. Most of the various systems have been used successfully at one time or another, but quite often they have failed to accomplish the desired ends.

The real objective in attempting to control skylight brightness is to diffuse the incoming light as much as possible, thereby spreading the brightness of the skylight over as large an area as possible. To illustrate the accomplishment of this objective, let's assume that we have a two-foot-square skylight with a translucent dome having a given transmission factor. Assume conditions that provide a level of illumination, at some plane, of 30 footcandles. We then enlarge the skylight to twice its original size, four-foot-square, and cut down the transmission factor, to maintain the same level of illumination, and let through the same quantity of light as before. We still have an illumination level of 30 footcandles, but the brightness of the dome is much less, since we have spread the same "amount" of light over a larger area.

Another approach to cutting down the skylight brightness has been to add another diffusing material to the light well in the form of a ceiling dome. While this significantly reduces the dome brightness it also reduces the illumination level in the room to such a point that the ratio between task and skylight brightness, which is the real criteria for evaluating seeing conditions, remains about the same with or without the ceiling dome. This is illustrated by the data shown in Fig. 10. This does not remain entirely true, of course, when considering the ratio of skylight brightness to a task brightness located away from the skylights and near the fenestration. However, the data in Fig. 10 do indicate that the value of the ceiling dome is somewhat limited.

TRANSMISSION FACTOR	8%	14%	20%	28%
PLASTIC DOME SKYLIGHTS	1:9.8	1:10.3	1:11.8	1:12.2
SKYLIGHTS & CEILING DOMES	1:10.1	1:11.3	1:11.8	1:12.7

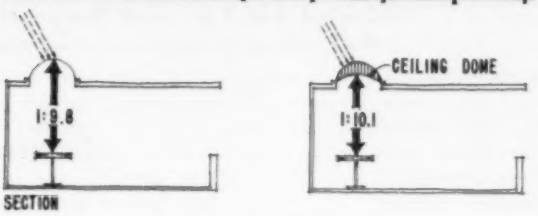

Figure 10. Brightness ratios for various skylight transmission factors and ceiling domes.

Research has so far indicated that the performance of skylights is dependent primarily on the transmission factor, the diffusing character of the skylight material, and the size of the skylight. Any good skylight material should be highly diffusing so as to spread the light over the entire skylight surface and avoid "hot spots." The amount of light to be received inside the building and the skylight brightness can be controlled by the size of the skylight and its transmission factor. The use of the sun lamp and sky dome has made possible the study of all dome materials, sizes and arrangements of skylights as well as many other building design considerations.

Conclusions

Predetermination of the natural lighting conditions inside buildings through the use of models tested under a simulated sky and sun is now feasible. Any building, regardless of size, shape or design, can be accurately and economically analyzed under any sky condition: overcast, partly cloudy, or clear with sunshine. No longer do architects have to guess at natural lighting conditions for their imaginative and nonconforming types of buildings. No longer do they have to "try-it-and-see" to determine the effects of their various new design schemes. Now they can have the answers in advance.

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Facts and Figures of IES

The General Secretary's Report, to be published in the December issue of ILLUMINATING ENGINEERING, is the official record of the Society's activities during the past year. The Report, which was presented at the opening session of the National Technical Conference in San Francisco, contains data on membership, finance, committee activities and publications for the 1958-1959 IES year.

I.E.S. Guide to

Design of Light Control

Part I—Physical Principles

Prepared by the Committee on Light Control and Equipment Design of the Illuminating Engineering Society

FOREWORD

The Light Control and Equipment Design Committee was established over ten years ago to develop material to serve as a guide to the principles and practices of light control. The Committee first developed reports on characteristics of materials for light control. During the last four years, the Committee has been intensively engaged in developing this Guide, the first two parts of which have been completed.

COMMITTEE ON LIGHT CONTROL AND EQUIPMENT DESIGN

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1. Introduction

The study of light control is primarily divided into three general fields: Geometrical Optics, Physical Optics and Quantum Optics (Corpuscular Theory). This Guide for application to illuminating engineering deals primarily with geometrical and physical optics as Part I, and the design of optical elements as Part II.* The simpler principles in Part I are explained by Physical Optics, the more complex principles by Geometrical Optics.

2. Waves and Rays

(a) The directional control of light is primarily achieved by means of reflection or refraction. This control can be interpreted by means of a wave theory. When wave trains spread out from a point in a uniform medium, the fronts of the waves form concentric spheres (spherical waves) around the source (Fig. I-1). These wave fronts are similar to the waves which result from dropping a stone in a pool of water. At great distances from the center of the source, the wave fronts are so large that small areas may be considered as flat planes, and treated as plane waves.

(b) In most cases, the movement of wave fronts may be represented by assuming a ray of light as being a line drawn perpendicular to the wave front in the direction the wave is traveling (Fig. I-2).

3. Huygens' Principle

(a) Using Huygens' Principle,[1] the shape of a wave front traveling at velocity v can be constructed for time t_2 from the known shape of the wave front at time t_1. This is illustrated in Fig. I-3 where X-X represents the known wave shape at time t_1, traveling as indicated by the small arrows.

(b) A number of small circles are constructed with centers on the known wave front X-X, and whose radii are of length $r = v(t_2 - t_1)$. Connecting the outermost points on these circles forms a curve Y-Y, which represents the new wave front at time t_2.

(c) It is possible to show what occurs in light control by successive applications of Huygens' Principle. In complex cases it is usually easier to follow the path of a few rays through the system and then reconstruct the final wave fronts at right angles to the rays.

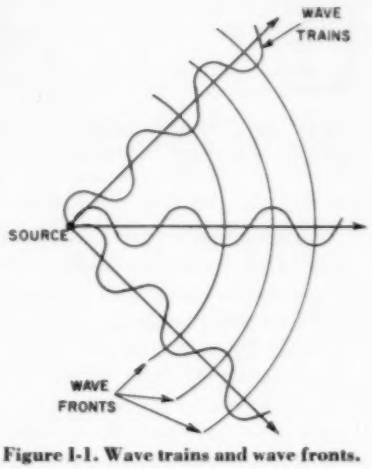


Figure I-1. Wave trains and wave fronts.

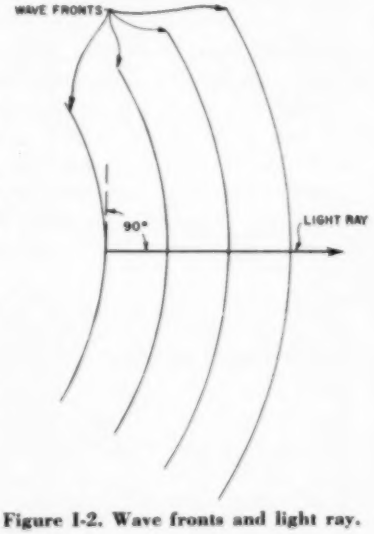


Figure I-2. Wave fronts and light ray.

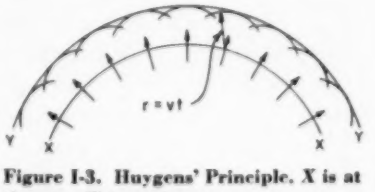


Figure I-3. Huygens' Principle. X is at time t_1. Y is at time t_2.

*To be published in the December issue of ILLUMINATING ENGINEERING.

Approved by the Council of the Illuminating Engineering Society, July 1958. A Transaction of the Society.

4. Reflection

4.1—General—The redirection of incident light by a reflecting surface is influenced by both the shape of the surface and the shape and direction of travel of the light wave front.

4.2—Reflection of a Plane Wave at a Plane Surface—**(a)** A plane wave is reflected from a plane surface with the angle of incidence equal to the angle of reflection. The angle of incidence is the angle formed by the direction of travel of the original wave and a line drawn normal to the reflecting surface. The angle of reflection is the angle formed by the direction of the reflected wave and the same line normal to the reflecting surface. (See Figs. I-4 and I-5.) The original wave is called the incident wave. The resultant wave is called the reflected wave.

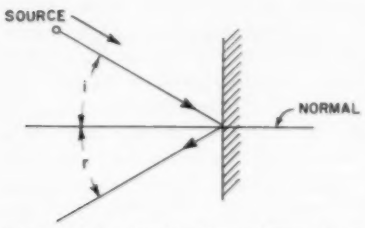


Figure I-4. Angle of incidence, *i*, is equal to the angle of reflection, *r*.

(b) When a plane wave such as *A-A'*, in Fig. I-5, strikes a plane surface *M-M'* at incident angle *i*, one end of the wave is reflected from the surface before the other end of the wave strikes the surface. By using Huygens' Principle, the future position of *A-A'* is shown successively by *O-B* and *P-C*. The reflected wave, *O-B'* and *P-C'*, may be constructed by the theorem that the angle of incidence *i* is equal to the angle of reflection *r*.

4.3—Reflection of a Spherical Wave at a Plane Surface—**(a)** A spherical wave directed at a plane surface is reflected from that surface as another spherical wave.

(b) A wave front being sent out from point *P*, Fig. I-6, is shown as *AVA'*. As it moves towards the reflecting surface *M-M'*, it is reflected back successively *BDED'B'* until it is completely reflected as *CV'C'*. This new wave *CV'C'* is another spherical wave whose new center *P'* is the same distance from the surface *M-M'* as was the center *P* of the original wave *A-A'*.

4.4—Reflection from Regular Curved Surfaces—**(a)** Fig. I-7 shows the reflection of a beam of light (parallel rays representing a plane wave) by a concave surface and by a convex surface. A ray of light striking the surface at *T* obeys the law of reflection, *i.e.*, the angle of reflection is equal to the angle of incidence. By taking each ray separately, the paths of the reflected rays may be constructed.

(b) In the case of parallel rays reflected from a concave surface, all the rays can be directed through a common point *F* by properly designing the curvature of the surface. This is called the focal point. The focal length is *f* (*FA*).

(c) By means of the simple law of reflection, the path of a group of rays may be easily constructed as shown in Fig. I-8.

5. Refraction

5.1—General—**(a)** A change in the velocity of light occurs when a ray of light leaves one medium and enters another of greater or less optical density. The speed will be reduced if the medium is more dense and increased if less dense.

(b) Generally, the velocity of light in a medium is less than its velocity in free space. The ratio of the velocity of a given wavelength of light in a vacuum to its velocity in a given medium is called the index of refraction of the medium.

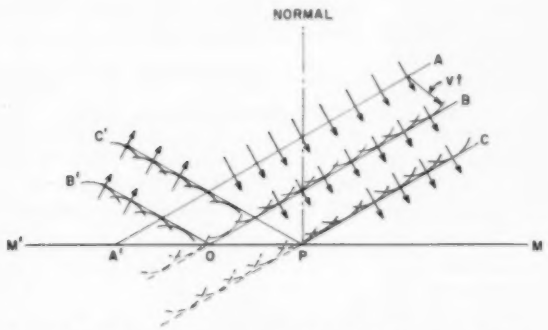


Figure I-5. Successive positions of a plane wave front as reflected from a plane surface.

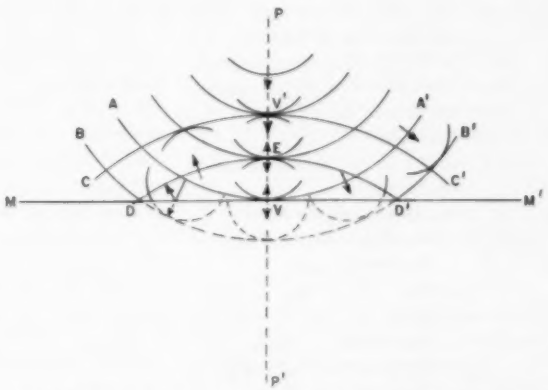


Figure I-6. Spherical wave reflected at a plane surface.

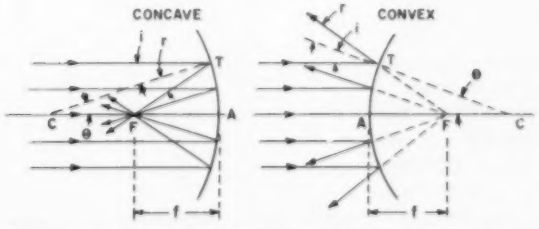


Figure I-7. Focal point and focal length of curved surfaces.

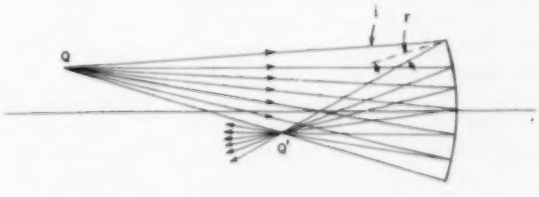


Figure I-8. Reflection from a curved surface.

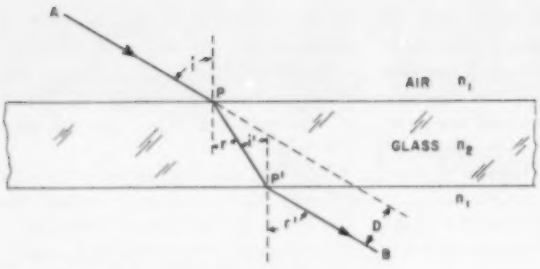


Figure I-9. (above). Refraction.

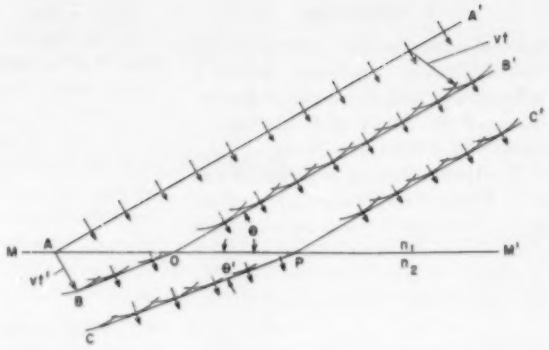


Figure I-10. (right). Successive positions of a plane wave front refracted by a plane surface.

$$\text{index of refraction } (n) = \frac{\text{velocity of light in a vacuum}}{\text{velocity of light in a medium}}$$

(c) The index of refraction of a medium is a function of the wavelength of the light. For a given material it will vary for different wavelengths. For example, the index of refraction of air for red light (656 millimierons) is 1.0002914; for violet light (436 millimierons) 1.0002957. For most purposes the index of refraction of air is assumed to be unity (1) for all visible light.

(d) When light enters at an angle (other than normal) to the surface of a medium of different density, the change in speed is accompanied by a bending of the light from its original path at the point of entrance (Fig. I-9). This is known as refraction.

(e) The degree of bending depends on the relative densities of the media, the wavelength of the light, and the angle of incidence.

(f) The law of refraction[1] (Snell's Law) is expressed:

$$n_1 \sin i = n_2 \sin r$$

where n_1 = the index of refraction of the first medium

i = the angle the incident light ray forms with the normal to the surface.

n_2 = the index of refraction of the second medium

r = the angle the refracted light ray forms with the normal to the surface.

(g) When the first medium is air, of which the index of refraction is 1, the equation becomes:

$$\sin i = n_2 \sin r$$

(h) The laws of refraction may be summarized as follows (see Fig. I-9):

(1) When a ray of light passes at an angle from a less highly refractive medium to a more highly refractive medium, it is bent towards the normal (air to glass).

(2) When a ray of light passes at an angle from a more highly refractive medium to a less highly refractive medium, it is bent away from the normal (glass to air).

(3) Regardless of the angle of incidence, the index of refraction is a constant for a given medium at a given wavelength.

***5.2—Refraction of a Plane Wave at a Plane Surface*—(a)** When a plane wave traveling in one transparent medium, such as air, strikes a second transparent medium, such as glass, two new waves are formed. One is the reflected wave, the direction of which is covered in 4.2 above and shown diagrammatically in Fig. I-5.

(b) The second is the refracted wave which passes into the second medium. In Fig. I-10, consider the plane wave front *A-A'* which is just approaching the surface *M-M'* of the second medium. Let n_1 be the index of refraction of the medium above *M-M'* and n_2 be the index of refraction of the medium below *M-M'*. Let it be further assumed that n_2 is greater than n_1. By using Huygens' Principle and Snell's Law, we can construct the direction of travel of *A-A'* as it enters into the second medium below *M-M'*.

***5.3—Refraction of a Spherical Wave at a Plane Surface*—(a)** An incident spherical wave does not remain spherical after refraction at a plane surface. If Huygens' Principle is applied to the refraction of a spherical wave at a plane surface, the mathematical concepts become extremely complicated and cumbersome. It is, therefore, much easier to understand if a few of the rays along the wave front are used.

(b) Fig. I-11 shows a construction using three rays along the wave front. If a ray of light from point *P* is directed at a point *Q* on the surface *M-M'*, the angle of incidence is θ. As this ray enters the medium behind *M-M'*, it is refracted away from the normal ($n_1 < n_2$). If the refracted ray is projected backwards, it intersects the normal at a new point *P'*, which is above the originating point *P*. The distance *VP'* is nearly always the same for all rays making small angles with the normal. Therefore, all rays from *P* which lie near the normal appear to diverge from *P'* after refraction by the surface.

***5.4—Refraction by a Plane Parallel Plate*—**Fig. I-9 shows the effect of refraction by a plane parallel plate such as a piece of flat glass. Two important points are shown here:

(1) The emergent ray $(\overrightarrow{P'B})$ is parallel to the incident ray $(\overrightarrow{AP})$.

(2) The incident ray $(\overrightarrow{AP})$ is not deviated in passing through the piece of glass but is displaced by a distance

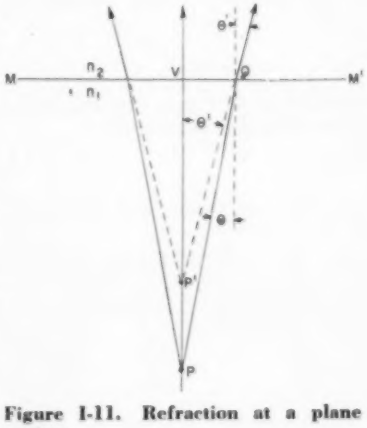


Figure I-11. Refraction at a plane surface.

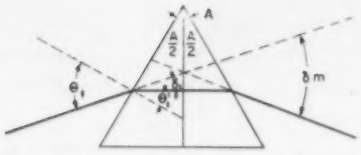


Figure I-12. Refraction by prism and angle of minimum deviation, δ_m.

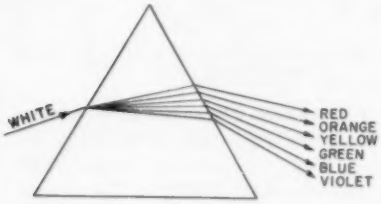


Figure I-13. Dispersion by a prism.

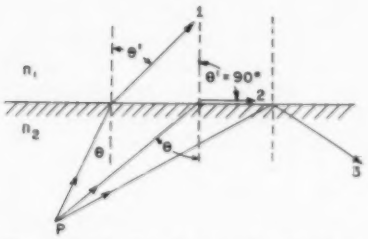


Figure I-14. Total internal reflection.

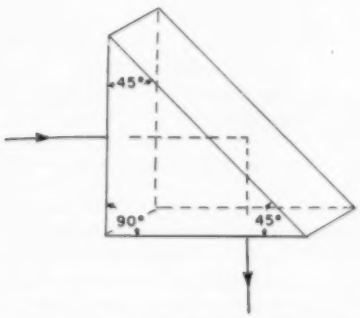


Figure I-15. A totally reflecting prism.

D. The theory of this is covered in 5.1 above.

5.5—Refraction by a Prism — **(a)** In the refraction of a ray by a plane parallel plate the ray is not deviated but displaced, while in refraction by a prism the light ray is deviated. Fig. 12 shows the path of a monochromatic light ray through a prism. If the light ray passes through the prism symmetrically, the minimum deviation results.

(b) The relative index of the prism for this case is:

$$N = \frac{\sin 1/2(A+\delta_m)}{\sin 1/2\, A}$$

where A = the angle of the prism (see Fig. I-12), and

δ_m = the minimum angle of deviation.

(c) If the angle of the prism A is small, the angle of minimum deviation is also small. Therefore, the sine of the angles in the above equation may be replaced by the angle which the sine represents. This useful approximation results:

$$N = \frac{A+\delta_m}{A}$$

or

$$\delta_m = (N-1)\, A$$

(d) The angle of deviation other than the minimum angle may be found graphically by tracing the ray path through the prism. This is done by computing the angle of refraction at the first surface and plotting the result. The direction of the emerging ray is then known. By measuring the angle between a projection of the original ray and the emergent ray, the deviation may be found.

5.6—Dispersion—The index of refraction of a medium is a function of wavelength. This variation in refraction combined with the deviation of a light ray by a prism results in the dispersion (breaking up) of the different wavelengths of light which are in the original light ray. Fig. I-13 shows the common effect of white light dispersed by a prism.

6. Total Internal Reflection

(a) Fig. I-14 shows three rays from a point source P in a medium of index n_2. In this figure $n_2 > n_1$. Snell's Law shows us that:

$$\sin \theta' = \frac{n_2}{n_1} \sin \theta.$$

(b) Since n_2/n_1 is greater than one, $\sin \theta'$ is larger than $\sin \theta$, and evidently equals one ($\theta' = 90$ degrees) for some angle of θ less than 90 degrees. This is shown by ray 2, which just grazes the surface upon emerging at an angle of refraction of 90 degrees. The angle of incidence of this ray 2, which results in an angle of refraction of 90 degrees, is called the critical angle (θ_c). The critical angle for two media is:

$$\sin \theta_c = n_1/n_2$$

(c) If the angle of incidence is greater than the critical angle (ray 3), the light ray does not pass into the upper medium but is totally reflected internally in the first medium. The critical angle of glass prism in air (Fig. I-15) with glass of an index of refraction of 1.50 is:

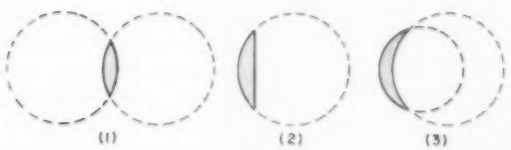
$$\sin \theta_c = \frac{1}{1.50} = 0.67,$$

and $\theta = 42$ degrees.

Therefore, a prism whose angles are 45, 90, 45 degrees is a totally reflecting prism.

7. Lenses

7.1—General—A lens is an optical system bounded by two refracting sur-



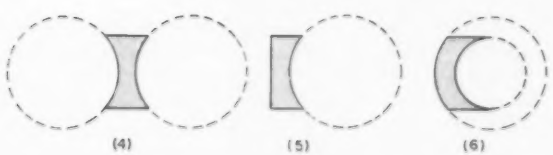
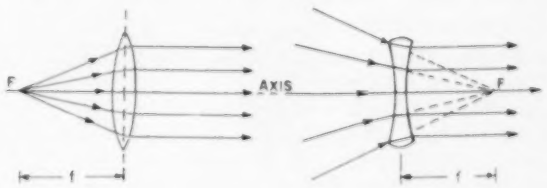


Figure I-16. (left). Forms of lenses: (1) double-convex, (2) plano-convex, (3) positive-meniscus, (4) double-concave, (5) plano-concave, (6) negative-meniscus.

Figure I-17. (below). Primary focal point and focal length.



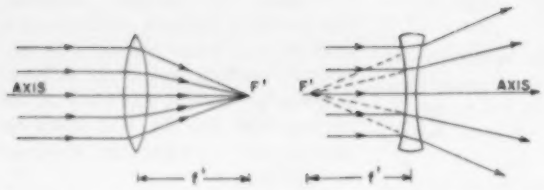


Figure I-18. Secondary focal point and focal length.

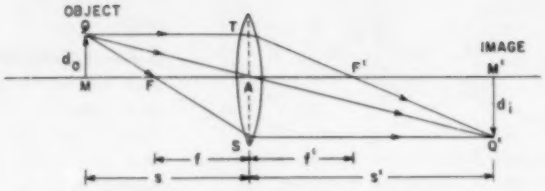


Figure I-19. Graphical determination of an image.

faces having a common axis.[1] Problems associated with lenses may be solved by applying the principle of refraction to each surface of the lens as light passes through it.

7.2—Types of Lenses—There are basically six types of lenses (see Fig. I-16):

A. Positive or converging lens. Thicker at the middle than at the edges.

(1) Double-convex, Equiconvex = both surfaces convex;

(2) Plano-convex = one surface convex, one plane

(3) Positive meniscus = one convex, one concave.

B. Negative or diverging lens. Thinner at the middle than at the edge.

(4) Double-concave, Equiconcave = both concave;

(5) Plano-concave = one concave, one plane;

(6) Negative meniscus = one concave, one convex.

7.3—Focal Point and Focal Length—**(a)** Fig. I-17 shows the refraction of light by a double-convex and by a double-concave lens. The primary focal point F lies on the axis, and for a positive lens is the point from which diverging rays are refracted by the lens in a parallel beam.

(b) For a negative lens, the primary focal point is the point toward which the rays must converge in order to be refracted into a parallel beam. The secondary focal point is the reverse of above, as shown in Fig. I-18. A plane perpendicular to the axis at the focal point is called the focal plane. The distance between the center of the lens and its focal point is the focal length (f or f'). In air $f = f'$. (See Figs. I-17 and I-18.)

7.4—The Thin Lens Equation—Given the focal length of a thin lens (one whose thickness is small in comparison to its focal length) and the distance of an object from the center of the lens, the location of the image, as shown in Fig. I-19, may be expressed as follows:

$$\frac{1}{s} + \frac{1}{s'} = \frac{1}{f}$$

When using this equation, the following algebraic signs should be observed for all of the results to have meaning:

(1) All figures should be drawn with the light traveling from left to right.

(2) All object distances (s) are positive when measured from the center of the lens to the left; negative when measured to the right.

(3) All image distances (s') are positive when measured to the right of the lens, and negative to the left of the lens.

(4) Both focal lengths (f and f') are positive for converging lenses and negative for diverging lenses.

(5) Transverse (vertical) directions are positive above the axis, and negative below the axis.

7.5—Magnification—**(a)** In the above section, only the position of the image formed was discussed. The size of this image may be expressed as follows:

(referring again to Fig. I-19) $md_o = d_i$ where m is the constant of magnification, d_o is the height of the object, and d_i is the height of the image.

(b) The constant of magnification may be expressed:

$$m = \frac{-s'}{s}$$

where m is the constant of magnification, s is the distance from the center of the lens to the object, and s' the distance from the center of the lens to the image.

(c) Where s and s' are both positive, as in Fig. I-19, the negative sign of magnification indicates an inverted image.

7.6—Thick Lenses—Where the thickness of the lens cannot be considered small (thin), as compared to its focal length, the thin lens equation does not apply. Thick lenses are not within the scope of this report and, therefore, for more information a text on optics should be consulted.

7.7—Lens Aberrations—Aberrations are departures of the actual image from the calculated image. Lens aberrations are usually of little importance in common types of lighting equipment. There are two general classifications of aberrations: chromatic and monochromatic.

A. Monochromatic aberrations are:

(1) Spherical aberration — failure of a lens to form a point image of a point object;

(2) Coma—see (1);

(3) Astigmatism—see (1);

(4) Curvature of field—see (1);

(5) Distortion—variation of magnification.

B. Chromatic aberrations (failure of lens to form a sharp image because of color dispersion) are:

(1) Longitudinal chromatic—variation of image distance;

(2) Lateral chromatic—variation of image size.

8. Interference

(a) Much of the previous material has been based on the assumption that light travels in straight lines and that the rays of light are deviated through definite angles at surfaces separating two media.

(b) The fundamental point of view shows that light is really a wave motion. At any point where two or more waves cross, they are said to interfere.

(c) The brilliant colors that may be seen when light is reflected from a soap bubble or a film of oil are produced by the interference effect of two light waves reflected at the opposite surfaces of the thin films of soap or oil.

(d) Fig. I-20 shows this interference effect. Part of the incident light ab is first reflected as bc. Part is refracted as bd, which again reflects as de, and finally emerges as ef. If wave bc and ef have appreciable width of

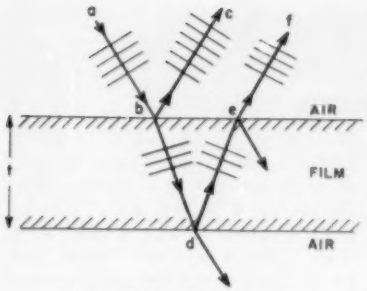


Figure I-20. Interference.

wave fronts, they will overlap and interfere.

(e) The phenomenon of interference is used in producing so-called nonreflecting glass. This is the effect resulting from a thin film of transparent material on the surface of the glass, with the film thickness one-fourth of the wavelength of the light striking the glass. (The index of refraction of the film should be between that of the glass and that of the medium surrounding the glass.) Under this condition, the light reflected from the first surface is 180 degrees out of phase with the light reflected from the second surface, and complete cancelling interference will result. In practice, the over-all reflection from a lens or prism surface can be reduced in this manner from about five per cent to a fraction of one per cent.

9. Diffraction

If it is assumed that light travels in a straight line, an opaque object placed between the light source and a screen should produce a sharp shadow. This is not necessarily the case. Light is actually traveling in a wave form. Depending upon the geometrical relationship between light source, object, and screen, the shadow may not be sharp but may be a series of fuzzy and ill-defined shadows. This phenomenon, known as diffraction, is seldom of much consequence in ordinary lighting equipment applications.

10. Polarization

(a) Conventional light sources emit light waves which vibrate in all directions in planes at right angles to the direction of the light beams. Many materials have the capacity to screen out the vibration in one direction, and the resulting beam is said to be partially polarized.

(b) A few materials have the characteristic properties of screening out all the so-called vibrations except those in one plane, and this is said to be complete polarization.

(c) The common methods used in producing polarized light are generally:

(1) Reflection;
(2) Pile of plates;
(3) Dichroism;
(4) Double refraction;
(5) Scattering.

References

1. Sears, Francis Weston, and Zemansky, Mark W.: *University Physics*, Addison-Wesley Publishing Co., Inc., Cambridge 42, Mass. 1955.

Waist-High Roadway Lighting

Over 700 42-inch fluorescent fixtures, mounted 50 inches above ground in extruded aluminum railings, provide even light distribution on New Jersey's newly-opened Monahawkin Causeway Bridge, N. J. Highway 72. Fixtures are installed in the lower front quadrant of the elliptical railings and are spaced about two feet apart all along the 2400-foot four-lane highway. All light is directed on the road, at right angles to traffic.

Advantages experienced from this "waist-high" lighting system include:

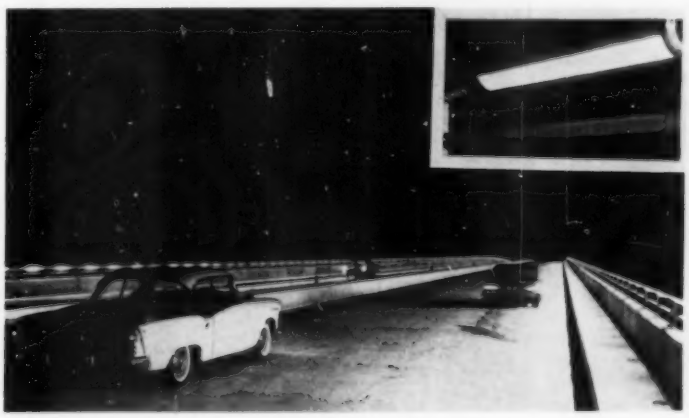
(1) With all light concentrated on roadway and parapets in shadow, driver's attention is directed on road;

(2) Reduction of glare;

(3) Horizontal direction of light increases the effectiveness of the system in rain, snow and fog;

(4) With all fixtures accessible from the bridge walkways, servicing is simple and involves no obstruction of the oncoming traffic.

Photo and data are courtesy of General Electric Co., Schenectady, N. Y.



Badge of honor—Fellow pins presented by President Taylor (left) to B. C. Cooper, G. W. Clark, E. A. Linsday, R. D. Bradley, L. E. Johnson, R. T. Dorsey. Absent were new Fellows Stanley McCandless and Priscilla Presbrey.

President's Reception. Some 750 people at the banquet were received by the guests of honor, President and Mrs. G. J. Taylor (left) and the incoming Presidential couple, Mr. and Mrs. J. B. Browder.

Progress in Lighting, the Progress Committee's wonderful show, was the highlight of the Monday evening activity. Presiding here in "Westward-Ho" costume is Committee Chairman E. A. (Red) Linsday.

Past-President's Luncheon, an important Conference tradition. Present, around the table: K. M. Reid, E. M. Strong, Willard C. Brown, Julius Daniels, George W. Crompton, J. B. Browder (standing and host to his predecessors), L. V. Graves, A. F. Wakefield, R. W. Hartenstein and G. J. Taylor.

LIGHTING NEWS

1959 National Technical Conference

Actually the IES National Conference is the biggest thing in lighting, wherever it's held. Everything else being equal, however, Nob Hill is a plus. In this year's instance, so were the inspired extras to the usual Conference program (see page 20A), and the professionally-smooth conference organization under John S. Walsh's direction. Read on, for details.

Annual Report

There are two sessions at every IES National Conference which, with almost no exception, no delegate would miss. One is the Progress Report. The other is the opening session. This is a sort of "State of the Union" report by the President, General Secretary, and (for a statement of intentions) by the incoming President. Since last year, this has also comprised the Society's formal Annual Meeting, in former years held in New York City the first Monday in October. Understandably, the attendance in those circumstances was meager. A revision in the By-laws has placed this important Society event on the Conference program, at the opening session, with a member audience close to 800 or 900 participants. As with last year, questions put to the officers from the floor were pertinent, numerous and a valuable part of the Society's business.

Other features of the opening session will become, verbatim, a part of the Society's transactions. President George Taylor's Address, and the Vice-President's Report by J. B. Browder, were published in the September issue of ILLUMINATING ENGINEERING. The General Secretary's Report by James R. Chambers will be a feature of the December issue.

Also taking place at the opening session September 7 were presentations of the Society's highest honors. These are, of course, the IES Gold Medal and Certificate "for meritorious achievement which has conspicuously furthered the profession, art, or knowledge of illuminating engineering," the Society's highest honor, and the presentation of awards of Fellow, highest Grade in IES. The Medal itself had been presented to Dr. N. A. Halbertsma during ceremonies held during the CIE Congress in Brussels last June (see May 1959 IE, page 5A, and August 1959, page 25A). Additional recognition of this honor was made at the San Francisco Conference by R. F. Hartenstein, Chairman of the Medal Award Committee. Mr. Hartenstein outlined the history of the Medal, and cited details of Dr. Halbertsma's achievements in illumination. Dr. Halbertsma's acceptance was read by Professor E. M. Strong, and for the record is published on page 26A.

CONGRATULATIONS for a successful Conference in all departments to John S. Walsh (right), Conference Chairman, from IES President George J. Taylor.

Six of the eight recently-elected Fellows publicly received their white Fellow-grade lapel pins at the opening session. Presentation was by President Taylor to Berlon C. Cooper, George W. Clark, E. A. Linsday, R. D. Bradley, L. E. Johnson and R. T. Dorsey. Local New York and New Jersey Section meetings will later feature similar presentations to Stanley McCandless and Miss Priscilla Presbrey.

A final feature of the opening session was a report by Willard Brown on the 1959 Congress of the Commission Internationale de l'Eclairage held June 14-25, in Brussels. An interesting item of his report was his outline of what CIE is and what it does.

Technical Sessions

Three invited papers, two of them reporting recently completed Research Institute studies, were especially interesting additions to the program of technical papers. Mr. Ludwig Gaymard, Chief Lighting Engineer for Electricité de France journeyed from Paris to give his invited slide lecture showing the remarkably effective and yet esthetic practices in France for street lighting and for the decorative floodlighting of public buildings. IERI-sponsored studies reported were two just completed by Dr. H. R. Blackwell and B. S. Pritchard. One, "Determination of Light Levels for Roadway Visual Tasks," covered basic research on how much light is needed for safe seeing for pedestrian and vehicular safety. His findings, essentially establishing how much light is needed in the driving lane and how much in the curb lane, created great interest, and were also discussed at a press conference the following day. The Blackwell-Pritchard paper will be published in IE as an IERI report, following its final preparation and approval by IERI. Their other study, also of great interest and slated for publication, covered "Studies of Reflected Glare in Sample Office Areas."

In some cases triple sessions were required for the 38 papers presented at the San Francisco Conference, not including the Residence Lighting Forum program which included three valuable talks of special interest to this group. For the

(*Continued on page* 10A)

(Continued from page 9A)

record, a complete outline of the program is given, starting on page 20A.

Lighting Contest

No session paralleled the contest for "My Most Interesting Lighting Job," in both meanings of the word. In fact, the necessary paralleling of the two contests, for Class I and for Class II, created a problem for the hundreds who wished to see both phases of this popular Conference event. There were this year more entries than ever before; every Region was represented and for both classes, 22 entries in all. Installations winning the four top prizes for Class I and II are presented in this issue, starting with page 665. In addition to the cash awards given for the top four places in each class, both First Prize winners will receive miniature replicas of the Goddard Cup, and their names will be engraved on the Trophy itself.

Contestants for national honors, MMILJ—Commercial Lighting. Standing, l. to r.: John C. Epperson and Lloyd G. Dehrer, joint entry, South Pacific Coast Region; O. V. Stephens, Jr., Southwestern Region; Fred Farley, Pacific Northwest; Charles Strahan, South Central; Willard C. Brown, proxy for H. S. Williams Great Lakes; Joe Thomas, proxy for Gerard Denis, Canadian; J. Carl Wilson, contest chairman. Seated, left to right: Armand Zitelli, East Central; L. Ralph Bush, Southeastern; Fred Rosenquist, Inter-Mountain; Neil Thompson, Midwestern, and R. G. Williams, Northeastern.

CLASS I—RESIDENTIAL

Chairman—Carlton M. Thompson

Judges—J. E. Barnes, Virginia Skinner, Jan Reynolds, J. D. Whitnell

First Prize ($100)—F. Brendan Burke, Western New York Section, Great Lakes Region.

Second Prize ($50)—Sylvan R. Shemitz, Connecticut Section, Northeastern Region.

Third Prize ($25)—Sara Perkins, Georgia Section, Southeastern Region.

Fourth Prize ($15)—R. L. Sawyier, Golden Gate Section, South Pacific Coast Region.

Runners-Up—Frank G. Reed, Canadian Region; Simon Ehrlich, East Central Region; Vivian B. Hamilton, Inter-Mountain Region; Elsie Claiborne, Midwestern Region; A. Natalie, Pacific Northwest Region; Edna P. Fortier, South Central Region; Mary Wallace, Southwestern Region.

CLASS II—COMMERCIAL

Chairman—J. Carl Wilson

Judges—Roy E. Dahlin, R. F. Hartenstein, John Neidhart, Raymond L. Smart.

First Prize ($100)—John C. Epperson and Lloyd G. Dehrer (joint entry), Golden Gate Section, South Pacific Coast Region.

Second Prize ($50)—H. S. Williams, Ohio Valley Section, Great Lakes Region.

Third Prize ($25)—R. G. Williams, New York Section, Northeastern Region.

Fourth Prize ($15)—L. Ralph Bush, Georgia Section, Southeastern Region.

Runners-Up—Gerard Denis, Canadian Region; Armand Zitelli, East Central Region; Fred Rosenquist, Inter-Mountain Region; Neil J. Thompson, Midwestern Region; F. M. Farley, Pacific Northwest Region; Charles E. Strahan, Jr., South Central Region.

The MMILJ entry from the Southwestern Region was presented in the national contest by O. V. Stephens, Jr., electrical engineer for Brown & Root Inc. of Houston, Texas. Due to a misunderstanding, Mr. Stephens was not given credit on the program as the author of the project entered, for which he was the designer.

One very interesting aspect of the contest this year was the presentation on tape with slides, of four of the Class I entries, including the job which won first prize. Unable to attend the conference, these four—F. Brendan Burke, F. G. Reed, Simon Ehrlich and Vivian B. Hamilton—had their entries tape recorded and participated in absentia in this way. The taped presentations with slides also shown, were quite effective. Indeed, one of them won the contest.

Awards

The Gold Medal, the Fellow Pins, and the Contest Prizes, are, of course, coveted awards presented during a National Technical Conference. There are others, all keenly contested and pridefully received.

A plaque for the greatest gain in membership within a Region was won by the Canadian Region, and accepted by J. Carl Wilson, RVP, during the Banquet ceremonies.

(Continued on page 13A)

Conference Statistics

Time: September 7-11, 1959

Place: Fairmont and Mark Hopkins Hotels, San Francisco, Calif.

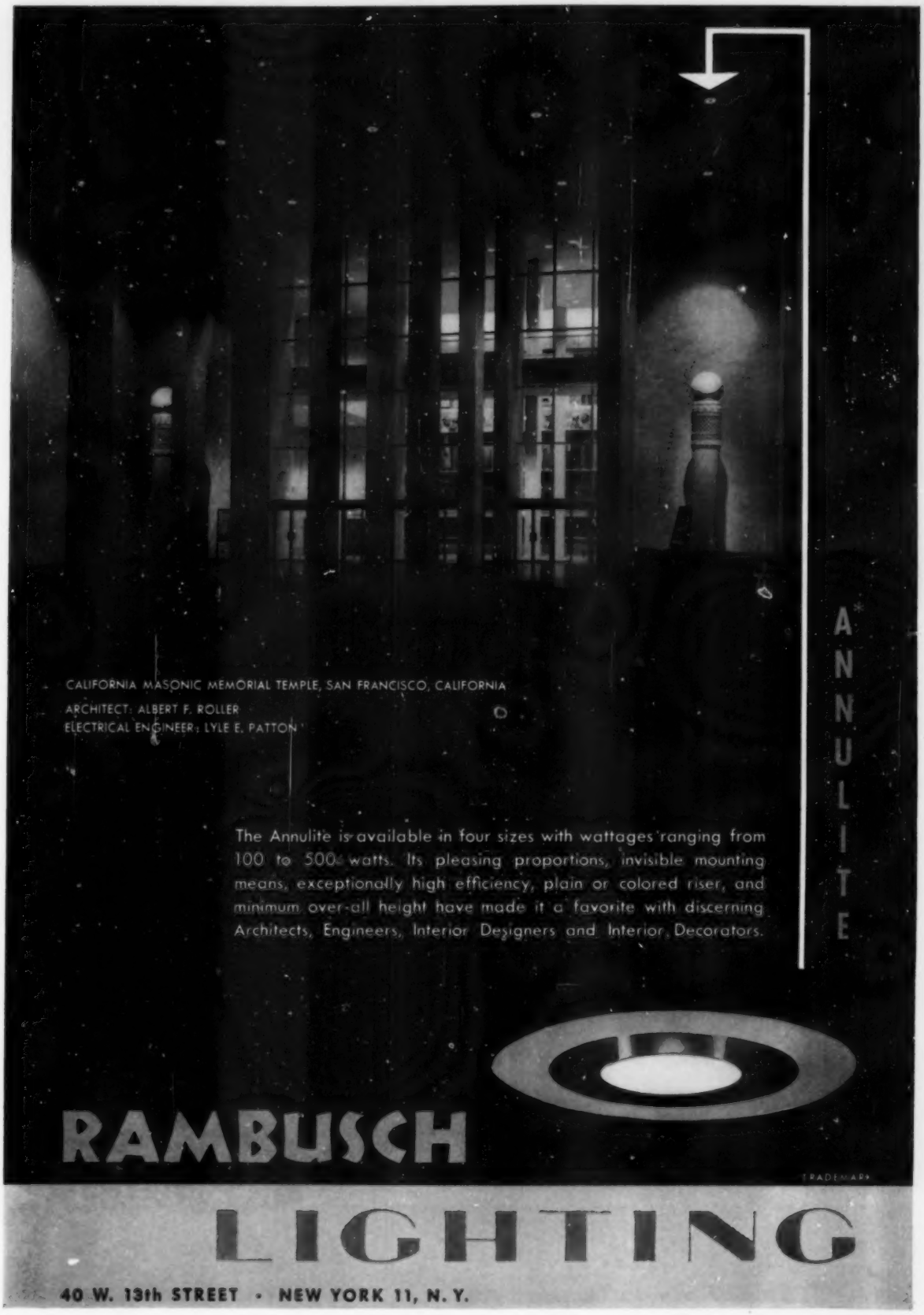
Conference Chairman: John S. Walsh

Attendance:

Delegates	630
Ladies	214
Total	844
Banquet Attendance	760

Attendance Award Winner: New England Section

Sections/Chapters Represented: 57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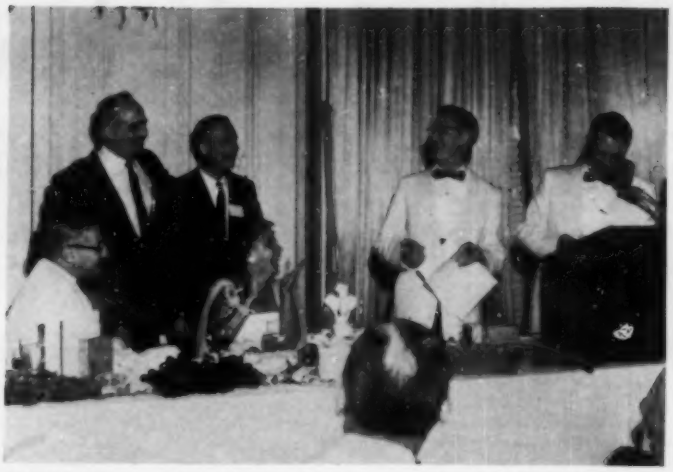


MMILJ Winners, Class II, were John C. Epperson and Lloyd G. Dehrer (left) from Golden Gate Section, South Pacific Coast Region. Sharing the exciting moment of the announcement are President George J. Taylor and MMILJ Chairman J. Carl Wilson.

New England Section, 53 strong, won the "Travel Gavel." Here, Ray Smart, Northeastern RVP and a member of the Section, accepts gavel and anvil attendance award.

(*Continued from page* 10A)

The annual award of Gavel and Anvil, for Section or Chapter attendance at the Conference, in relation to miles traveled and in percentage of Section total members, was taken home for the New England Section this year. The award was made to Raymond L. Smart, Northeastern RVP, and one of the 53 New England Section members who travelled all the way from the Boston area to the San Francisco Conference.

The sports minded will be interested to know that the Clarence Law Trophy (18-hole handicap competition) was won by Ernest Stohlman, St. Louis Section. The Regar Cup, awarded for low gross Section or Chapter team of four, went to the Southern California Section. The team: J. S. Hamel, Frank B. Lee, J. Bibb and A. Rowe.

"Son et Lumière"

One of the most impressive and successful projects ever undertaken for an IES meeting was a Pageant of Light and Sound, on Monday night at Grace Cathedral. Staged for the single performance and specially for IES, this was, in effect, the first American installation of a "Son et Lumière" display previously seen only at Versailles and Vincennes in France, and at Salisbury Cathedral in England. It would be almost impossible to overstate the effectiveness of this wonderful spectacle. Lights in varying colors were played in predesigned patterns and effects against the imposing facade and stained glass windows of the Cathedral—an inspiring setting ideally suited to this new art form. The light and color effects were subtly coordinated with the changing moods of the story narrated during the performance, describing man's slow climb from barbarism into civilization through the use of light. This also coordinated with a swelling concert of appropriate music and the famous carillon of the Cathedral bells. It was an experience no one present will ever forget. San Franciscans as well as IES people were held spellbound by the spectacle of drama, poetry and music, all enhanced by lighting which forsook its customary functional role to take its place among the art forms.

Design, direction and installation of the spectacle was by James Jewell of the Holzmueller Corp., San Francisco, and all of the lighting equipment was used courtesy of that company. Sound engineering was developed by Harold Bonner, working with organist Richard Purvis on the music. Master electrician was Jack Philpot.

The excellent script narrated throughout the performance contributed greatly to the impressiveness of the performance. Script and narration was by William Siden.

All of this was worked out with the cooperation and assistance of the Very Reverend C. Julian Bartlett, the Dean of Grace Cathedral. Credit is also due in great measure, for additional assistance, to the San Francisco Division of the Pacific Gas and Electric Co., Shalda Manufacturing Co., and the San Francisco Police Department, who arranged for cleared streets and rerouted traffic during the outdoor performance around the Cathedral.

A final measure of the success of this beautiful display is the information that Dean Bartlett is considering "Son et Lumière" as a regular Cathedral feature at Christmas and Easter. If so, San Francisco may have one more famous event added to its attractions.

San Jose Chapter Garden Lighting Tour

Breath-taking though the Cathedral pageant of "Son et Lumière" was, one would be hard put to judge *any* lighting project against the exceptionally beautiful garden lighting demonstration developed especially for the 1959 National Technical Conference by the San Jose Chapter. This exhibition of remarkably beautiful garden lighting effects was installed, again for the single performance, throughout the many-acred Menlo Park estate of *Sunset Magazine* (Lane Publishing Co.). Several hundred IES delegates and ladies journeyed in a cavalcade of buses to these beautiful gardens after dark on Wednesday evening, and spent several hours wandering their paths, viewing the unusual lighting techniques. These were demonstrated, some by new individual frequency remote control, by members of the San Jose Chapter, whose special project this was.

So impressed were the *Sunset* people with the new night-time beauty of their gardens, that they too are considering a permanent installation. And so the gospel spreads.

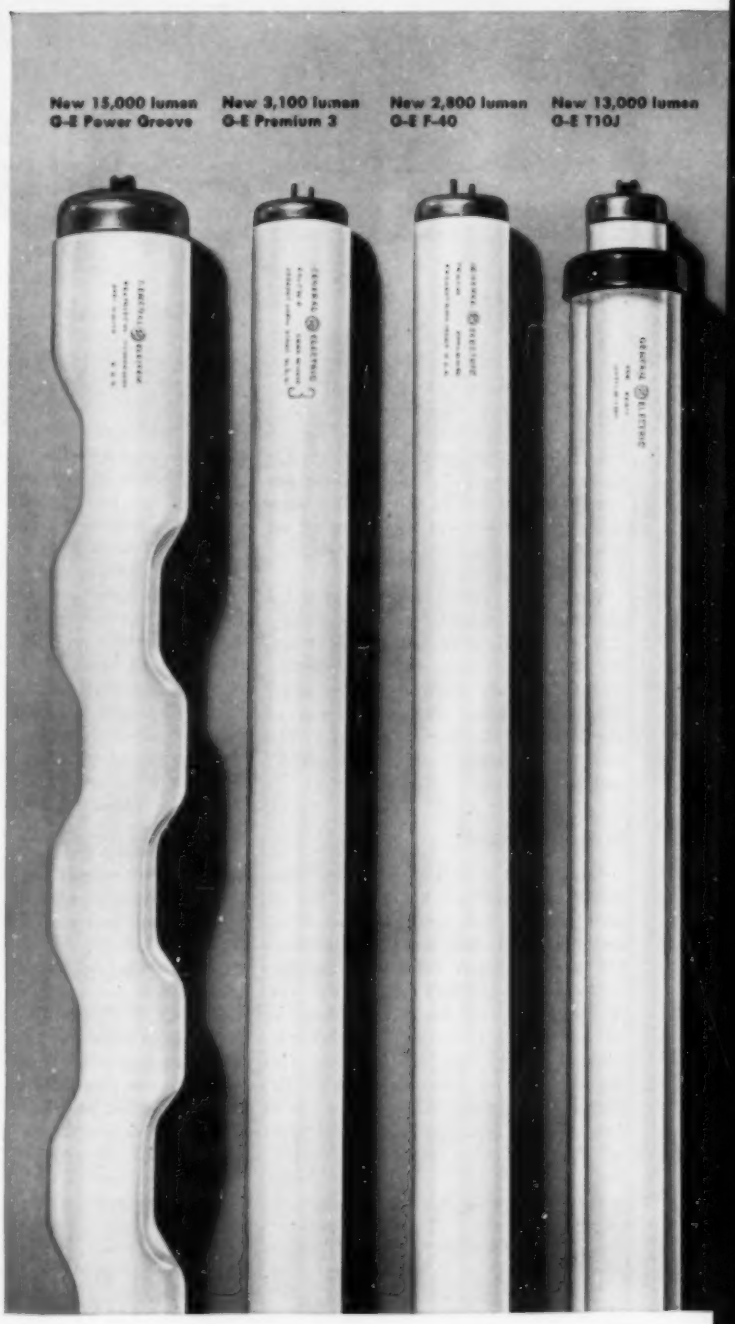
Lamplighters' Street Lighting Tour

Golden Gate Section, the Conference host, has within it a unique organization of street lighting engineers known as the "Lamplighters." This group is frequently the originator of within-the-Club activities, and on the occasion of the San

(*Continued on page* 17A)

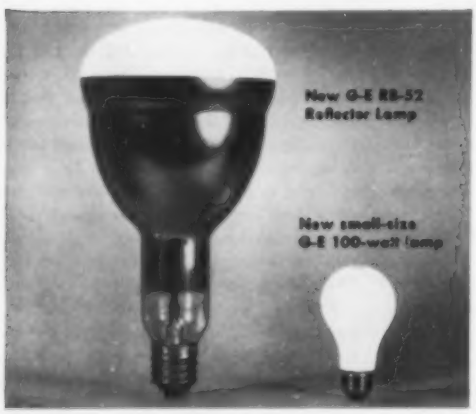
Here are the most dramatic new lamps this year...and every one came first from General Electric!

Further proof...your best bargains in light are General Electric fluorescent, filament and mercury lamps



4 NEW G-E FLUORESCENT TYPES

(1) Multiple Power Groove, most powerful fluorescent you can buy, saves up to 40¢ a square foot initial investment over other fluorescents. (2) The F-40, for universal use, *costs 5¢ less* . . . and *delivers 6% more light* than previous 40-watt G-E Rapid Start Lamps. Operates in starter-type circuits, too. (3) PREMIUM 3, first 40-watter ever to exceed 3,000 lumens (3,250 in white), also operates in either type of circuit. (4) The T10 is the first fluorescent lamp ever designed for outdoor use. Rated at 13,000 lumens and designed for *enclosed single lamp fixtures* it stays brighter even in cold, windy weather. The T10J (shown at right) is a T10 lamp fitted with a glass jacket and is made for *exposed lamp installations.*

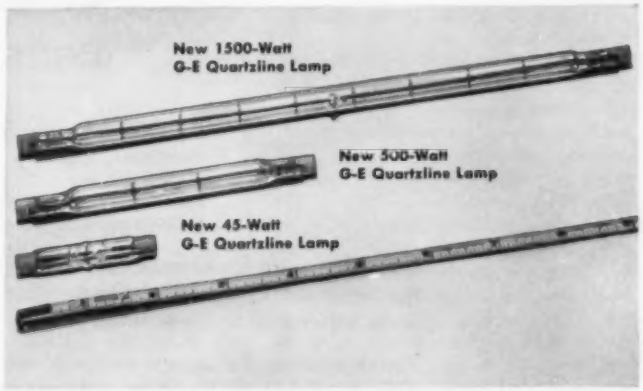


2 NEW G-E BONUS LINE FILAMENT LAMPS—(1) *New smaller 100-watt bulb* . . . small as a 60-watt, but delivers more initial light than two 60's. More light than any previous 100-watt bulb. How? With the General Electric "stand-up" filament that delivers more light. (2) *New G-E RB-52 Reflector Lamp* has special "bulge" shape to distribute heat, permits economy of regular glass construction; silver reflector instead of aluminum; the first thousand-watt reflector lamp with the "stand-up" filament . . . puts 20-30% more light on work area.

FIRST COMPLETE LINE OF 400-WATT BONUS LINE MERCURY LAMPS—Bonus Line Mercury Lamps give users more light for the electricity, and like other General Electric Mercury Lamps, at any given time in their life, will outperform any other brand the same age. What's more, they're built to last as long or longer than any other. Bonus construction eliminates arc tube blackening. Choose from six G-E Bonus Line 400-watt Mercury Lamps.

NOW—MORE ECONOMICAL FLOOD-LIGHTING IN COLOR—Dramatic new 100-watt G-E color PAR Lamps for display or decoration, available in red, yellow, blue, green, pink and blue-white. Newly developed silicon coating lets more light through—positively won't crack in rain or snow.

FREE FROM G.E.—Right now... today you can get a startling new 20-page picture paper packed with factual information on lamps and lighting that can help your customers save big money. For your free copy just send your name and address to General Electric Co., Large Lamp Dept. C-937, Nela Park, Cleveland 12, Ohio. Be sure to ask for "FACTS OF LIGHT". See your G-E Large Lamp Representative for larger quantities.



3 NEW G-E QUARTZLINE LAMPS—Smallest, brightest, most efficient incandescent lamp ever offered commercially. Packs tremendous amount of light into tiny unit (1/200th the size of other lamps of equal wattage). Pencil-thin, now available in 45-, 500- and 1,500-watt sizes. No lamp blackening, no dust accumulation. Rugged quartz tube won't crack even if splashed with ice water.

WHICHEVER LAMP YOU RECOMMEND, know how your customers' lighting costs break down. For example, on 40-watt fluorescents, his costs average only 10% for lamps, so even a 50% lower price would cut his costs by just 5%. Electricity uses 70%. The other 20% is maintenance (here G-E Lamps really save money!). Across the board they're more uniform in light output, predictable life, color and freedom from defects. They're right at the start . . . and have fewer early burnouts, so maintenance costs drop. This same uniformity makes all G-E Lamps your customers' BEST BARGAINS in light.

Progress Is Our Most Important Product

GENERAL ELECTRIC

ONE OF THE EARLIEST LIGHT SHIELDS

Its chief advantage: the Boss couldn't tell when you were sleeping.

Its biggest disadvantage: it worked only for the one individual who wore it...and not too effectively at that.

But now...with the fixtures and the lamps already on the market and with the newer ones continually being developed to meet Blackwell recommendations, better shielding is a "must."

Today plastics offer a combination of exceptional advantages unavailable in older materials for shielding, diffusing or controlling light. And when you think of plastics, think of *extruded plastic* as the efficient way to achieve modern shielding.

Low brightness prismatic panels (such as our **EXTRU-LITE®**), large wrap-around enclosures or just plain side-panels—it makes no difference, extruded plastics by Rotuba cost no more. **YET YOU CAN BE SURE** they are made with the finest materials obtainable. Experienced supervision and quality control go into the manufacture of each and every part that leaves our plant in a pre-tested and approved shipping carton.

REMEMBER ROTUBA —
THE NAME YOU CAN DEPEND ON FOR MODERN SHIELDING

Manufacturers will want to have our newest Mailer. It shows *in actual size* a wide variety of shapes being made for lighting and gives design suggestions to consider when planning new shapes. Write for it today.

© Reg. T.M.

THE ROTUBA EXTRUDERS, INC.
A DIVISION OF WALJOHN PLASTICS, Inc.
MAKERS OF PLASTIC EXTRUSIONS FOR INDUSTRY
437 88th STREET, BROOKLYN 9, NEW YORK • SHORE ROAD 8-5458

ADDITIONAL OFFICES: O'Connell & Associates, Chicago, Ill., AMbassador 2-8841
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Plaque for the greatest gain in membership was won by the Canadian Region. Accepting the award from President Taylor is Canadian RVP J. Carl Wilson, right.

To the Taylors, left, a gift from South Pacific Coast Region, Conference hosts. Beautiful Steuben glass bowl was presented by John S. Walsh, right.

(Continued from page 13A)

Francisco Conference arranged a special program for visiting street lighting experts. The Lamplighters were host to some 57 IES members from all parts of the country at a special dinner, followed by a five-hour bus tour throughout the San Francisco Bay area. On a sort of "busman's holiday," the street lighting men viewed lighting for bridges, tunnels, highway and directional sign lighting, and of course the new high level whiteway lighting in downtown San Rafael.

A highlight of the dinner meeting was the origination of a Lamplighters' Pledge, which is now being made up into suitable certificates to be sent to all who attended this "conference within a conference." Their hope is to further the formation of similar Lamplighter groups in other Sections and Chapters. Text of their pledge is shown in the box elsewhere on this page.

Social Events

In reporting a Conference, an account of the fun people had could well come first. Certainly it will be remembered with pleasure long after the technical details become items of reference. And the IES gift for good entertainment and hospitality obviously extends from coast to coast.

On the West Coast, it even started two days before the Conference. Early arrivals got together Saturday night (September 5) for a Sportsman's Buffet at the Fairmont. In the main, these were the hardy souls who planned to start out at 5 a.m. Sunday morning to have breakfast together in Sausalito—before heading out to deep waters, and hopefully, 25-pound fish. A surprisingly large number of conference visitors were this hardy. The fishing boat was well filled. Prizes were awarded for the largest fish — a silver cup to John S. Walsh of San Francisco, for first prize. Second prize went to Frank E. Duhme, Jr.; third in this event was Roy Wagner.

Rigorous day or no, however, they all got back in time to attend a lovely party Sunday evening, hosted by the Golden Gate Section. This was an informal reception at the Fairmont and a wonderful opportunity for reunions. An additional treat was Willard Brown's briefing of what went on at CIE in Brussels last June—and his wonderful colored slides of the rest of his European trip.

Monday evening's entertainment was double-barrelled. As soon as it was dusk, IES'ers lined the steep street before Grace Cathedral to view the remarkable Pageant of Light and Sound already described. From this they hastened directly to the Progress Report presented by Chairman E. A. Linsday and his committee. Actually the Progress Report is the work of a technical committee of IES and its substance is valuable lighting information on new developments. Its presentation, however, is so interesting and entertaining that no one present, ladies included, would ever miss this show. As usual, the hotel's largest space was packed solid, with latecomers standing along walls.

Not even technical sessions interfered with Tuesday's entertainment. None was scheduled for the afternoon and the whole convention moved 20 miles to the Orinda Country Club. In this short distance from San Francisco's 65-degree

(Continued on page 20A)

Lamplighters' Pledge

WHEREAS this distinguished group of Doctors of Lumenology have met for the common good and the safety of the traveling public and whereas it is the intent of this dedicated group of Lamplighters to further the safety of the night owls, we hereby pledge, upon receipt of an authentic Lamplighters Certificate, to promote a Lamplighter group in our respective area to hear our plea for better lighting of America's Streets and Highways and to assist in the formation of Lamplighter programs in all areas of the country. This resolution duly passed hereby becomes an official proceeding of the Lamplighters assembled this date.

LAMPLIGHTERS OF AMERICA

September 9, 1959
Rickey's Restaurant
San Rafael, California.

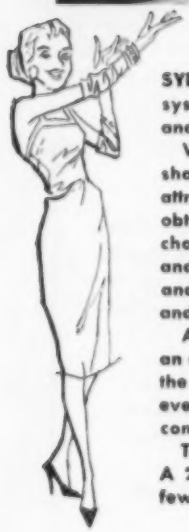
Choose from 3 *distinct and different*

Area Lighting Systems . .

Before you specify lighting again, take another look at the decided advantages of Area Illumination. See how it can add to and help your overall planning.

As a design element, today's completely or partially-luminous ceilings offer possibilities limited only by the designer's aims. Area Lighting can make the ceiling surface an integral part of your entire scheme, both esthetically and in space planning through partition coordination.

From a lighting viewpoint Area Lighting stands alone. No other present-day lighting method provides such comfortable, shadow-free and glare-free illumination regardless of lighting level.



SYLVA-LUME—This extremely versatile, modular system features an extruded aluminum grid work and offers unlimited flexibility and design freedom.

Vinyl plastic panels are provided in deep or shallow style—plain or patterned—in a choice of attractive colors. Single or double panels can be obtained. Optional acoustic baffles, also with a choice of colors, provide effective sound control and add another design element for delineation and emphasis. Perimeter panels give interesting and attractive border treatment.

All of these design factors can be utilized for an endless variety of ceiling patterns . . . allowing the addition of a distinctive personal touch to every installation from a relatively few catalogued components.

The standard Sylva-Lume module is 3' x 3'. A 2' x 2' module is also available with only a few limitations in variety.

SYLVA-CELL—This Sylvania modular system utilizes a 2' x 4' module and features a continuous pattern of cells. A choice of two attractive louvers is offered—polystyrene plastic or white painted aluminum, both with 45° x 45° shielding. Each ceiling offers excellent efficiency and shielding together with an even, widespread distribution of diffused illumination.

Sylva-Cell's simple, inverted-T grid work of extruded aluminum has extreme versatility for complete or partially-luminous ceilings. The louvered pattern can be used from wall to wall. Or, if desired, the interspersing of standard opaque ceiling materials makes a change in appearance, yet uses the same suspension system.

With Sylvania's minimum number of precision-made parts, installation is simple and fast. The open pattern of cells results in extremely minor problems of maintenance.

Go modern...with a Sylvania Lighting System!

.. by SYLVANIA

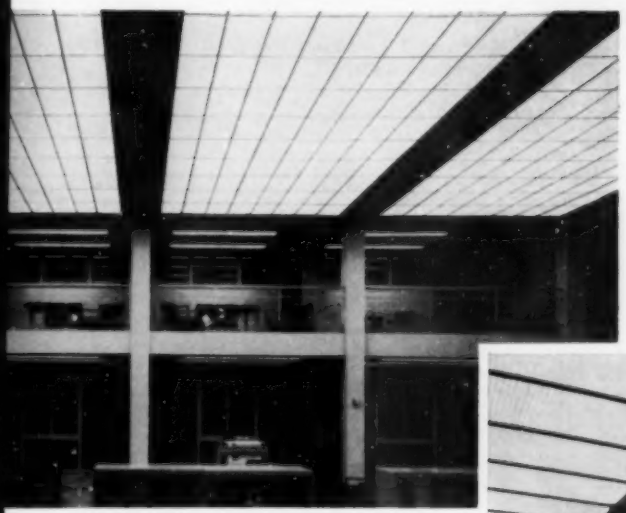
At Sylvania continual progress has been made in Area Illumination since providing the first catalogued lighting system over ten years ago. As shown below, Sylvania now offers 3 distinct and different Area Lighting Systems. All 3 systems use standard components and each one provides top-quality, efficient illumination together with smooth, uncluttered appearance.

These systems have been developed and perfected to give the designer almost unlimited freedom of expression. Color and patterns can now provide exciting vitality to routine ceiling areas.

Unique, specially-designed parts allow Sylvania Systems to be installed quickly and easily, reducing installation time and costs, and widening the application possibilities of Area Lighting in both new and modernization projects.

The next time, when you want lighting that is truly outstanding, look to Area Illumination . . . and think first of Sylvania where you have a choice of three Area Lighting Systems.

SYLVANIA LIGHTING PRODUCTS
A Division of SYLVANIA ELECTRIC PRODUCTS INC.
Department 59-7
One 48th Street, Wheeling, West Virginia



SYLVAN-AIRE—Sylvania's established area lighting system, featuring 3' wide rows of corrugated vinyl plastic, offers a most economical method of obtaining area illumination.

Sylvan-Aire offers two versatile suspension methods . . . Uni-Space and Vari-Space . . . making installation simple for any desired footcandle level. This system is easily adjusted for installation of air conditioning components, for spotlights, to fit around columns and other obstructions, or for partition planning.

Acoustic baffles are available, too, as optional equipment. When ordered, acoustic baffles are supplied pre-assembled to the support channels thus requiring no additional installation time.

SYLVANIA

Subsidiary of
GENERAL TELEPHONE & ELECTRONICS

GENERAL SYSTEM

FLUORESCENT LIGHTING FIXTURES AND SYSTEMS • BEST FIXTURE VALUE IN EVERY PRICE RANGE

(*Continued from page 17A*)

weather, suddenly it was summer, with swimming, tennis and basking. A western Chuck Wagon picnic featuring 14-ounce steaks was a wonderful windup.

On Wednesday evening buses again moved large segments of the delegation to (a) the Street Lighting Tour and/or (b) the Garden Lighting Exhibit at Menlo Park, both previously described.

Winding up the Conference in a brilliant social whirl was a banquet and dance, honoring President and Mrs. Taylor. This was, of course, a social highlight and should be a source of pride and joy to the Entertainment Committee. As a lasting reminder of this great moment in their lives, the Taylors were presented with a beautiful Steuben glass bowl as a gift of the Region.

For the ladies, the above was only part of the fun. Their own program started every morning at nine, with breakfast together in their own hospitality suite. With "Baghdad-by-the-Bay" as a fascinating background, their excursions and trips filled every day. Some of these: Luncheon at Kan's, with Chinese costume and cuisine; a tour of the Napa Valley vineyards and wineries, with lunch at Beringer Brothers, prize winning vintners; Fisherman's Wharf via cable car, and lunch there of course; a tour of the harbor; shopping in Chinatown — 'twas a very busy week for all concerned.

1959 Conference Sessions

September 7

Opening Session

Presiding—Charles L. Amick, Chairman, National Technical Conference Committee

National Officers Report
President, George J. Taylor
General Secretary, James R. Chambers
President-elect, Joseph B. Browder

Introduction of Fellows, 1959

I.E.S. Medal Award—Report on Medal Award to Dr. N. A. Halbertsma at C.I.E Meeting, Brussels—R. F. Hartenstein, Medal Award Committee.

Report on C.I.E. Meeting, Brussels—Willard C. Brown.

IES Conference Attendance Past Ten Years

1949	French Lick, Ind.	668
1950	Pasadena, Calif.	556
1951	Washington, D. C.	765
1952	Chicago, Ill.	859
1953	New York, N. Y.	1007
1954	Atlantic City, N. J.	857
1955	Cleveland, Ohio	754
1956	Boston, Mass.	960
1957	Atlanta, Ga.	926
1958	Toronto, Ont.	970
1959	San Francisco, Calif.	845

Regional V-P's and their wives and IES staff were luncheon guests of Mr. and Mrs. J. B. Browder, incoming Presidential couple.

Applications Session (Parallel)

Chairman—F. W. Sell, Detroit Edison Co., Detroit, Mich.

Discussion Organizer—John Haney, Crouse-Hinds Co., Syracuse, N. Y.

Integrated Lighting—Air Conditioning Systems —W. S. Fisher and J. E. Flynn, General Electric Co., Cleveland, Ohio.

Performance Characteristics of Combination Air Diffusing Troffers—M. L. Quin, Day-Brite Lighting Inc., St. Louis, Mo., and W. W. Kennedy, Barber-Colman Co., Rockford, Ill.

Designing Low Brightness Luminaires for Higher Lighting Levels—Q. D. Dobras and D. R. Phillips, General Electric Co., Cleveland, Ohio.

A Constant-Wattage Ballast for Two or More Mercury Lamps — V. W. Olson, Jefferson Electric Co., Bellwood, Ill.

External Control of Mercury Pressure of Fluorescent Lamps and Its Application to Luminaires—P. J. Underwood and C. E. Beck, General Electric Co., Cleveland, Ohio.

Photometry and Daylighting (Parallel)

Chairman—J. W. Griffiths, Southern Methodist University, Dallas, Texas.

Discussion Organizer—O. F. Wenzler, Libbey-Owens-Ford Co., Toledo, Ohio.

Measuring Fluorescent Lamp Characteristics for the Outdoor Environment—P. R. Herrick and R. E. Wenner, General Electric Co., Cleveland, Ohio.

On the Foundations of Goniophotometry — Domina Eberle Spencer, University of Connecticut, Storrs, Conn., and S. M. Gray, Sylvania Electric Products Inc., Salem, Mass.

A New Method for Studying Effects of Direct Sunlight on Building Interiors and Subsequent Skylight Studies—Ben H. Evans and Matthew A. Nowak, Texas Engineering Experimental Station, College Station, Texas.

Evening Sessions

Pageant of Light, Grace Cathedral—Presiding —James Jewel, Holzmueller Corp., San Francisco.

Lighting Progress—Presiding—E. A. Linsday, Chairman, Committee on Lighting Progress.

September 8

Research and Application (Parallel)

Chairman—C. M. Cutler, General Electric Co., Cleveland, Ohio.

Discussion Organizer—J. J. Neidhart, The Miller Co., Meriden, Conn.

The Lighting of Streets and of Public Buildings in France—L. Gaymard, Street Lighting Chief Engineer, Eletricité de France, Paris, France.

Determination of Light Levels for Roadway Visual Tasks—H. R. Blackwell and B. S. Pritchard, The Ohio State University, Columbus, Ohio.

Comparison of Visibility Measurement Systems —Arthur A. Eastman and Sylvester K. Guth, General Electric Co., Nela Park, Cleveland, Ohio.

Studies of Reflected Glare in Sample Office Areas—B. S. Pritchard and H. R. Blackwell, The Ohio State University, Columbus, Ohio.

Light Sources and Application (Parallel)

Chairman—T. C. Sargent, Sylvania Electric Products, Inc., Salem, Mass.

Discussion Organizer—A. W. Weeks, Champion Lamp Works, Lynn, Mass.

Phosphors for Electroluminescent Lamps — L. W. Strock, Sylvania Lighting Products, Inc., Salem, Mass.

Problems and Progress in Electroluminescent Lamps—Henry F. Ivey, Westinghouse Electric Corp., Bloomfield, N. J.

Electroluminescent Sources in Automotive Instrument Lighting—J. M. Harris, Sylvania Electric Products Inc., Salem, Mass., and P. J. Blinkilde, Chrysler Corporation, Detroit, Mich.

Significant Advances in the Design of Non-Circular Cross-Section Fluorescent Lamps— J. O. Aicher and E. Lemmers, General Electric Co., Cleveland, Ohio.

Factors Influencing the Design of Extra Output Fluorescent Circular Cross-Section Lamps — C. J. Bernier, Sylvania Electric Products, Inc., Danvers, Mass.

Residence Lighting Forum (Parallel)

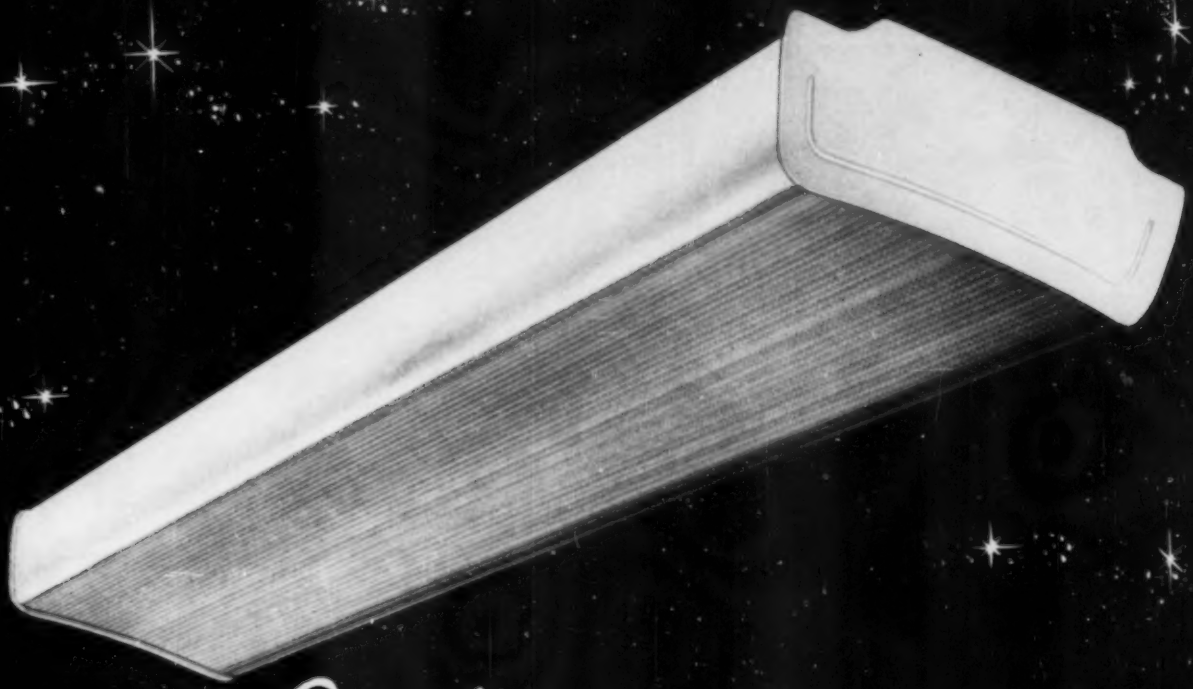
Chairman — Virginia Skinner, Chairman of Residence Lighting Forum Committee.

New Opportunities for Home Decorations from Today's Christmas Lamps — W. D. Jones, General Electric Co., Nela Park, Cleveland, Ohio.

The Use of Lighting to Change Mood and Atmosphere—William Blitzer, Lightolier Co., New York, N. Y.

The Viewpoint of the Editorial Group on Home Lighting—Walter Doty, Sunset Magazine, Menlo Park, Calif.

(*Continued on page 23A*)



PREMIUM *Quality* IN THE GARCY TRADITION

AVAILABLE NOW AT A LOW-BUDGET *Price*

The New *Gar-Lite* 101 by GARCY LIGHTING

Exclusive one-piece shield combines two tones, does two jobs

Diffuse white sides prevent objectionable side brightness

Clear prismatic bottom offers controlled high efficiency

Shield hangs down from either side on continuous hinge

Two-lamp unit (illustrated) is less than 9″ wide, 3¼″ deep

Exact 48″ length; joins end to end quickly and easily

Write for Bulletin 59

AVAILABLE THROUGH SELECTED GAR-LITE DISTRIBUTORS

GARCY LIGHTING

DIV. OF GARDEN CITY PLATING & MFG. CO.
2475 ELSTON • CHICAGO 47, ILLINOIS

NEW HEAT-RESISTANT REFRACTORS

made of a PYREX® glass by Corning for General Electric

Can you get an optically sound refractor that can stand up to high heat?

Yes — if it's made from PYREX brand glass No. 7740 like this General Electric No. 500, made by Corning for use in the "R" IES Type incandescent assembly with lamps up to 620 watts.

With a PYREX brand glass you don't worry about danger from thermal breakage because you have high strength and low expansion. Because a PYREX refractor is rugged, you have fewer worries about breakage from vandalism, too.

One more point: You get the optical specifications you need, because Corning is experienced not only in glass fabrication but also in optical research and design.

Let us help you solve your most pressing lighting problem. Spell it out in brief and send your note to Corning Glass Works, 61 Crystal Street, Corning, N. Y. You'll get a prompt answer.

PYREX refractor permits use of higher wattage lamps in this General Electric incandescent luminaire.

CORNING GLASS WORKS

CORNING MEANS RESEARCH IN GLASS

(*Continued from page 20A*)

Afternoon Session

Sports and Chuck Wagon Dinner — Orinda Country Club.

September 9

My Most Interesting Lighting Job Residential Lighting — Class I

Presiding—Carlton M. Thompson.
Judges—J. E. Barnes, Virginia Skinner, J. D. Whitnell, Jan Reynolds.
Canadian Region—Frank G. Reed, Toronto Section, Lighting Consultant and Architect, Toronto, Ont.—"Lighting the Canadian National Exhibition's Give-Away Home 1958."
East Central Region—Simon Ehrlich, Maryland Section, Excello Public Service Corp., Baltimore, Md. — "Lighting of Residence Using the Lumen Counter Method."
Great Lakes Region—F. Brendan Burke, Western New York Section, Ferguson Electric Construction Co., Buffalo, N. Y.—"Lighting His Own Home."
Inter-Mountain Region—Vivian B. Hamilton, New Mexico Chapter, Hamilton and Hamilton, Lighting Consultants, El Paso, Texas—"Relighting a Contemporary House with Movable Units."
Midwestern Region—Elsie Claiborne, Milwaukee Section, Wisconsin Electric Power Co., Milwaukee, Wis.—"Heirlooms Illuminated."
Northeastern Region—Sylvan R. Shemitz, Connecticut Section, C. S. Mersick Electric Supply Co., West Haven, Conn.—"Lighting for Relaxation."
Pacific Northwest Region—A. Natalie, Oregon Section, Pacific Power and Light Co., Portland, Ore.—"Masterpiece Home."
South Central Region—Edna P. Fortier, New Orleans Section, Edna P. Fortier Lighting Co., New Orleans, La.—"The Magic Ingredient."
Southeastern Region—Sara Perkins, Georgia Section, Georgia Power Co., Atlanta, Ga.—"Sara's Laboratory."
Southwestern Region — Mary Wallace, North Texas Section, Texas Power and Light Co., Dallas, Texas — "Lighting a Speculative Gold Medallion Home."
South Pacific Coast Region—R. L. Sawyier, Golden Gate Section, Pacific Gas & Electric Co., San Francisco — "Interesting Sources for Dramatic Dining."

Commercial, Industrial and Other Lighting — Class II

Presiding—J. Carl Wilson.
Judges—Roy E. Dahlin, R. F. Hartenstein, John Neidhart, Raymond L. Smart.
Canadian Region — Gerard Denis, Montreal Section, The Shawinigan Water and Power Co., Juliet, Que.—"Lighting of a Hardware Store."
East Central Region—Armand Zitelli, Pittsburg Section, Duquesne Light Co., Pittsburgh, Pa.—"Lighting Dramatics at American Legion Post No. 5."
Great Lakes Region—H. S. Williams, Ohio Valley Section, George F. Schatz and Associates, Cincinnati, Ohio — Lighting Music Hall Ballroom."
Inter-Mountain Region — Fred Rosenquist, Rocky Mountain Section, Public Service Co. of Colorado, Denver, Colo.—"Lighting in a Department Store."
Midwestern Region—Neil J. Thompson, Heart of America Section, Kansas Power and Light Co., Topeka, Kans.—"Dial Your Atmosphere."
Northeastern Region—Rollo G. Williams, New York Section, Century Lighting Inc., New York, N. Y.—"Canadian and Ontario Rooms in the New Extension of the Royal York Hotel."
Pacific Northwest Region—F. M. Farley, Oregon Section, Benjamin Electric Mfg. Co., Portland, Ore.—"Effect of Plenum Obstructions of a Luminous Ceiling in a Bank."
South Central Region—Charles E. Strahan, Jr., Mississippi Chapter, Mississippi Power and Light Co., Jackson, Miss.—"Relighting of Heidelberg Hotel Roof."
Southeastern Region—L. Ralph Bush, Georgia Section, Lighting Consultant, Atlanta, Ga.—"Floodlighting State Capitol Building."

South Pacific Coast Region held their Regional MMILJ contest Sunday evening before the Conference. Class I contestants (above): R. L. Sawyier, Helen Eldridge and W. J. Lochlin. In Class II contest (below) contestants were: Jack Adams, Mel Paul, R. J. Huff, Lloyd G. Dehrer and John C. Epperson (joint entry) and Earl Storrs.

Southwestern Region—O. V. Stephens, Jr., San Jacinto Section, Brown & Root, Inc., Houston, Texas—"Relighting a Paper Mill."
South Pacific Coast Region—John C. Epperson and Lloyd G. Dehrer, Golden Gate Section, Peerless Electric Co., and Buonaccorsi & Murray, San Francisco, respectively—"Crocker Anglo National Bank."

Calculations (Parallel)

Chairman—R. S. Wiseman, U. S. Army Eng. Research and Development Laboratories, Fort Belvoir, Va.
Discussion Organizer—J. N. Robertson, Los Angeles Dept. of Water & Power, Los Angeles, Calif.
Programming the I.B.M. 704 Computer for Photometric Data Reduction, Documentation and Application—Alfred B. Gough, General Electric Co., Hendersonville, N. C.
Lighting Calculations for Thirty-Five Thousand Rooms—Philip F. O'Brien, University of California, Los Angeles, Calif.
Use of Computers in Design and Analysis of Luminaires—Bill F. Jones, Smoot-Holman Co., Inglewood, Calif.

Light Sources I — (Parallel)

Chairman—J. L. Cox, Duro-Test Corp., North Bergen, N. J.
Discussion Organizer—George Gilleard, Curtis-Allbrite Lighting Inc., Chicago, Ill.
Slow Decay Rates of Phosphors in Fluorescent Lamps—C. W. Jerome, Sylvania Lighting Products, Inc., Salem, Mass.
Electrostatic Coating of Silica on Incandescent Lamp Bulbs—N. J. Rainone, Westinghouse Electric Corp., Bloomfield, N. J.
The Role of Crest-Factor in Lamp Starting—G. A. Meyers and J. C. Heffernan, Sylvania Electric Products, Inc., Danvers, Mass.
New Parameters for High Frequency Lighting Systems — John H. Campbell, General Electric Co., Cleveland, Ohio.
Rhenium as an Incandescent Source—W. G. Matheson, Sylvania Lighting Products, Inc., Salem, Mass.

Evening Sessions

Lamplighters' Tour and Dinner.
Garden Lighting Exhibition.

September 10

Light Sources II (Parallel)

Chairman—Kurt Franck, Holophane Co., Inc., Newark, Ohio.
Discussion Organizer—Alva B. Winters, Revere Electric Mfg. Co., Chicago, Ill.
Tensile and Thermal Stresses in the Envelope of High Brightness High Pressure Discharge Lamps — Wolfgang E. Thouret, Duro-Test Corp., North Bergen, N. J.

(*Continued on page 24A*)

L'Association Francaise des Eclairagists and the British IES sent personal greetings by Ludwig Gaymard, France (left), and E. J. Sherwood (Great Britain).

(*Continued from page* 23A)

Improvements in Fluorescent Lamp Efficiency Resulting from Particle Size Control of Phosphors—K. H. Butler and H. H. Homer, Sylvania Lighting Products, Inc., Salem, Mass.

Design Requirements for High Lumen Maintenance and Easy Starting of Mercury Lamps—E. C. Martt, A. C. Green and K. Gottschalk, General Electric Co., Cleveland, Ohio.

New Designs Revitalize Mercury Lamps and Increase Their Usefulness—W. S. Till and M. C. Unglert, Westinghouse Electric Corp., Bloomfield, N. J.

Roadway Lighting (Parallel)

Chairman—G. A. Trosper, Pacific Gas & Electric Co., San Francisco, Calif.

Discussion Organizer—Roy E. Dahlin, Southern California Edison, Los Angeles, Calif.

Evaluation of Methods for Localized Cooling of Fluorescent Lamps in Outdoor Luminaires—Merle E. Keck, Westinghouse Electric Corp., Cleveland, Ohio.

Improved Mercury Lamp Transformer for Maximum Regulator Loading on Series Circuits—M. E. Robertson, Jefferson Electric Co., Bellwood, Ill.

A Versatile Lighting System for Highway Tunnels — Harold Skootsky and John R. Brass, Division of Highways, State of California, San Francisco.

Relative Visual Comfort Evaluations of Roadway Lighting—C. H. Rex and J. S. Franklin, General Electric Co., Hendersonville, N. C.

Adaptation on Runway and Turnpike—Domina Eberle Spencer, University of Connecticut, Storrs, Conn., and S. C. Peck, Sylvania Electric Products, Inc., Salem, Mass.

Light Sources and Application (Parallel)

Chairman — E. H. Witte, Benjamin Electric Mfg. Co., Des Plaines, Ill.

Discussion Organizer—M. H. Kruger, Smithcraft Corp., Chelsea, Mass.

Proposed Method of Measuring the Hiding Power of Light Shielding Materials—W. O. Benjamin and C. W. Clarkson, Corning Glass Works, Corning, N. Y.

Iodine Incandescent Lamp with Virtually 100 Per Cent Lumen Maintenance—E. G. Zubler and F. A. Mosby, General Electric Co., Cleveland, Ohio.

Application of the Quartz Lighting Lamp—C. J. Allen and R. L. Paugh, General Electric Co., Cleveland, Ohio.

Application Possibilities of Wide Range Dimming of Fluorescent Lamps—Philip E. Massie, Day-Ray Products, South Pasadena, Calif., and Allen B. Rosenstein, University of California, Los Angeles, Calif.

Closing Session

Presiding—Charles L. Amick, Chairman, National Conference Committee.

Report of the Committee on Resolutions—Kirk M. Reid, Chairman Resolutions Committee.

Evening Session

Reception and Banquet in honor of President and Mrs. George J. Taylor and incoming President and Mrs. Joe B. Browder.

1959 Conference Executive Committee

Chairman—John S. Walsh, Pacific Gas and Electric Co., San Francisco

Program Vice Chairman — William L. Friend, Sylvania Electric Products, Inc., Burlingame

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George Baker	Q. R. Galloway
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S. O. Blois	W. D. Runswick
C. D. Buchanan	R. L. Sawyier
J. H. Burson	D. D. Scarff
W. A. Cyr	R. A. Schwartz
Guy de Leuze	C. M. Thompson
Frank Duhme	R. R. Tipton

G. A. Trosper

Finance

Chairman—Charles D. Buchanan
Runne A. Barnes — Robert G. Dunmel
Robert D. Thallon

Papers (Local Arrangements)

Chairman—Gilbert A. Trosper
Bruce Kunde — Vernon H. Waight
Richard L. Smith — C. M. J. Wood

Hotel

Chairman—George Baker
A. J. Bale — William L. Eliot
Fred J. Bertolone — E. P. Homer
John Clendenin — Dudley Moore
Warren Weiss

Registration

Chairman—James H. Burson
Bill Addison — Hunter Lauer
L. B. Craig — George Leyes
Rex Gardiner — Bob McKillican
B. B. Howard — Claude Parker
Stan Howatt — Lou Ridgeway
Bruce Kunde — Harold Skootsky
Jim Wrathall

Conference and Committee Rooms

Chairman—Robert A. D. Schwartz
A. W. Anderson — William Barton
Clifford L. Daly — John Schreiber

Audio-Visual

Chairman—Charles W. Macy
Adi Bana — R. L. Hoffman
Kent Bonney — James L. McAdoo
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John Gill — J. J. Sturgeon
Richard Grundy — Gene Ward
John Gumz — John Zehms

Lighting and Decoration

Chairman—Stanley O. Blois
James Jewel — Arch Monson

Printing

Chairman—Quince R. Galloway
Don Gray

Reception

Chairman—Donald D. Scarff
Mr. and Mrs. Ernest O. Anders
Dr. and Mrs. Leland H. Brown
Mr. and Mrs. O. Rodney Doerr
Prof. and Mrs. Daniel M. Finch
Mr. and Mrs. Robert C. Harper
Mr. and Mrs. Preston A. Jones
Mr. and Mrs. C. W. Leihy
Mr. and Mrs. Walter J. Maytham
Mr. and Mrs. Donald D. Scarff
Mr .and Mrs. Clarence C. Walker
Mr. and Mrs. John S. Walsh

Ladies' Reception

Chairman—Guy deLeuze
Vice-Chairman—Mark Jensen
Vice-Chairman—Mrs. John S. Walsh
Mrs. J. E. Barnes — Mrs Frank Duhme
Mrs. S. O. Blois — Mrs. Wm. L. Friend
Mrs. C. D. Buchanan — Mrs. R. L. Sawyier, Jr.
Mrs. Gilbert A. Trosper

Entertainment

Chairman—R. L. Sawyier, Jr.
Leonard Komor — Sydney Pankin
Bert Osterman — Grant Radford

Attendance

Chairman—Wallace D. Runswick
O. C. Westberg

Publicity

Chairman—William A. Cyr
Carl Albrecht — Robert Jackson

Sports

Chairman—Frank Duhme
Al Elufson — John Kinnaird
Ted C. Ciampi — Warren Weiss

Transportation

Chairman—Fred D. Benz
Edward Morgan

Progress

Coordinator—Robert R. Tipton
R. B. Marxheimer

MMILJ Regional Competition

Chairman—Carleton M. Thompson
J. W. Howard — A. D. Montgomery

Regional Attendance

Chairman—James E. Barnes, Regional Vice-President, South Pacific Coast Region
William P. Bear, Southern California Section
Gordon Burgess, Arrowhead Chapter
J. Walter Howard, San Diego Section
James Hunt, Yosemite Chapter
George J. Smedberg, San Jose Chapter
Leslie J. Van Nostrand, Mother Lode Chapter

Golden Gate Section

Chairman—John C. Epperson
Vice-Chairman—Walter G. Bayha
Secretary—Frank E. Duhme
Treasurer—A. S. Tylor

Managers

Charles W. Macy — James L. Wrathall
Guy de Leuze — Harold A. Wright

(*Continued on page* 26A)

NOW FROM BENJAMIN

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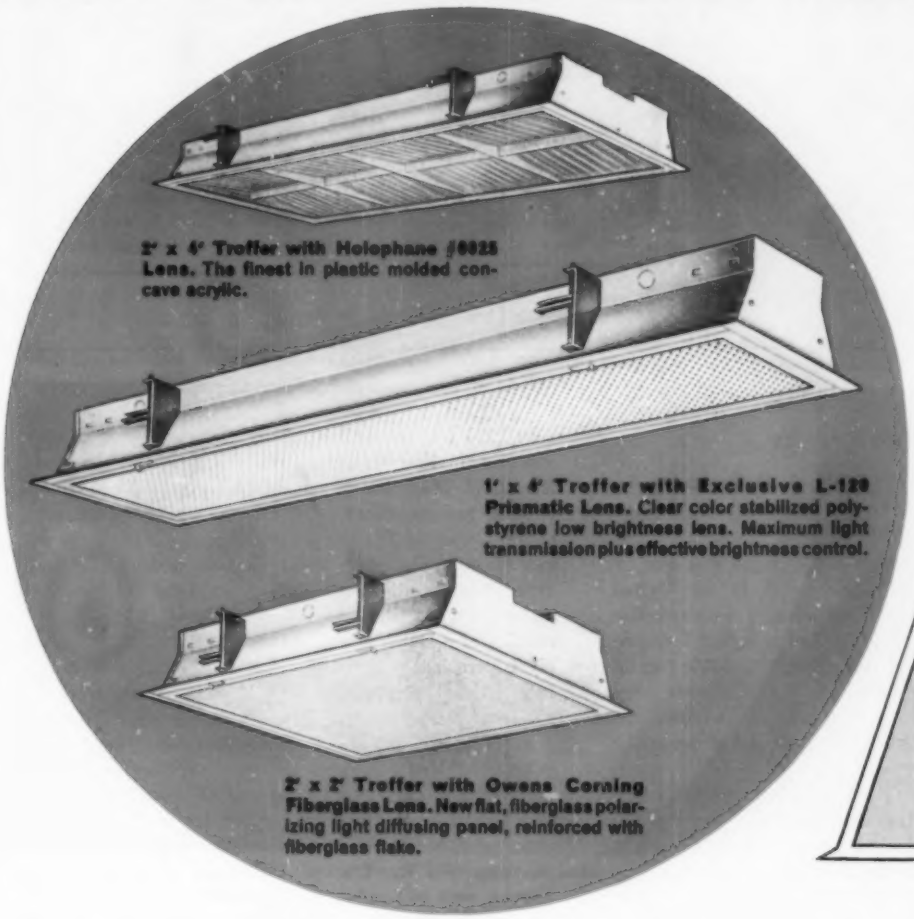
2' x 4' Troffer with Holophane #8025 Lens. The finest in plastic molded concave acrylic.
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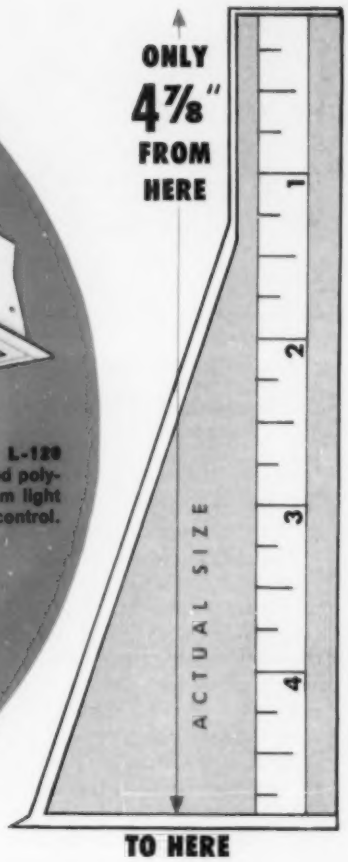
2' x 2' Troffer with Owens Corning Fiberglass Lens. New flat, fiberglass polarizing light diffusing panel, reinforced with fiberglass flake.



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New Benjamin shallow-line troffers are the fastest installing troffers on the market. One piece housing in both 4′ and 8′ units gives maximum structural strength. Fused for control equipment protection. The most complete selection of closures in the lighting industry.

For fixture engineering at its finest, look to Benjamin. Your local Benjamin representative will be happy to help you. Contact him on any problem... large or small.

- ✓ **Swivel-bar suspension eliminates overhead yokes, reduces installation cost**
- ✓ **Simplified hinge mechanism ...no screws to tighten**
- ✓ **Positive action tab-lock latch**
- ✓ **Housing fabricated and wired in one piece unit**

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BENJAMIN MOE LIGHT STAR LIGHT ENCHANTE AN MARINE

(Continued from page 24A)

National Technical Conference Committee 1958-1959

Chairman—Charles L. Amick

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J. W. Bateman	P. M. Rutherford
Brooks Chassaing	J. S. Schuchart
J. C. Forbes	F. W. Sell
W. P. Lowell, Jr.	C. C. Shotwell
C. W. McCormick	J. S. Walsh

J. C. Wilson

Papers Committee 1958-1959

Chairman—Floyd W. Sell

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B. S. Benson	O. B. Goldsmith
F. C. Breckenridge	J. W. Griffith
James Cox	T. C. Sargent
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H. F. Davidson	George Wakefield

R. S. Wiseman

Progress Committee 1958-1959

Chairman—E. A. Linsday
Vice-Chairman—M. K. Strang

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E. D. Altree	F. J. Marriett
H. A. Anderson	J. H. McCulloch
L. R. Bush	T. C. Sargent
Norman Falk	R. P. Teele
R. E. Faucett	R. F. Townsend
B. Goldberg	Robert R. Tipton
John Gornet	M. L. Trostle
A. R. Jaeger	H. A. Williams

Lighting Service Committee 1958-1959

Chairman—C. W. McCormick

A. C. Brodeur, Jr.	Joseph Thomas
Roy Dahlin	Carlton M. Thompson
W. E. Damuck	C. E. Waldron
R. F. Hartenstein	M. N. Waterman
J. D. Mitchell	J. D. Whitnell

J. C. Wilson

(News continued on page 29A)

Gold Medalists of I.E.S.

1944 . . . George H. Stickney
1945 . . . Preston S. Millar
1946 . . . E. C. Crittenden
1947 . . . Matthew Luckiesh
1948 . . . Sir Clifford Paterson
1949 . . . Ward Harrison
1950 . . . W. F. Little
1952 . . . H. H. Magdsick
1954 . . . E. F. Lowry
1955 . . . J. L. Stair
1956 . . . George S. Crampton
1957 . . . John O. Kraehenbuehl
1958 . . . C. A. B. Halvorson
1959 . . . N. A. Halbertsma

Gold Medal Acceptance Address

By N. A. Halbertsma

Mr. President and Members of IES:

Nearly forty years ago an excellent slogan was used in the first lighting demonstration centers in the United States: *seeing is believing.* Yet, when I received this spring a letter from Mr. Hinckley and saw that I was to be the recipient of the I.E.S. Gold Medal for 1959, I could hardly believe it. Five years ago I had already been among those elected Member Emeritus of your Society, and I considered this a recognition at the end of my career and appreciated that very much.

Your Award Committee and the Council of the I.E.S. were very generous indeed, when they decided to award the Gold Medal to me. I want to express my great gratitude, both for the medal and for the citation.

In that citation your Committee has called me an "Ambassador of Lighting." But I think that *every illuminating engineer* is an ambassador of lighting.

Year after year I have noticed with great interest the names of the recipients of the Gold Medal and the survey of the work they have done. Nearly all these Medalists I happened to know well, both personally and by their publications, which I hold in great esteem. Many of them have also participated in the work of the CIE.

May I state here what your Society has meant to me as a member *residing abroad.* From 1919 on I have been a regular and keen reader of your *Transactions.* These have kept me informed about everything that was done in the field of illumination in the United States. I still remember how happy I was when I succeeded in getting hold of the back volumes, right down to Volume I.

These *Transactions* were often a source of valuable information for me, until 1942, when a bombing attack caused a fire in my office and destroyed them all.

When inspecting the office some days later I found the floor covered with gray ashes, but near the wall where the bookshelf had been with the *Transactions,* the ashes were perfectly white, a proof of the excellent quality of the paper used for the printing.

In 1923 I made the first personal contacts with American illuminating engineers. I met Mr. S. E. Doane and Mr. H. H. Magdsick who came to Europe. For me this meeting had important consequences, for it became part of my job at the Philips Lamp Works to develop the international contacts for the promotion of good lighting. This led to my attending the meeting of the International Commission on Illumination at Bellagio in 1927 as a member of a Dutch delegation of two men only. Dr. E. P. Hyde presided at the meeting and the originator of the International Commission, Sir Clifford Paterson, acted as Honorary Secretary.

Sir Clifford was the first non-American recipient of your Gold Medal Award. At the Paris Session of the International Commission in 1948 the American Delegation had hoped to present the medal to him. However, because of ill health, Sir Clifford could not attend the Paris meetings. So Mr. Preston Millar and some of his colleagues went to London and presented the medal and the citation to Sir Clifford at his home. A few weeks later Sir Clifford passed away.

He was not only a great scientist, but also a wise man and an able diplomat, and as such eminently suited to bring the illuminating engineers of the world together.

I am greatly indebted to Sir Clifford Paterson for the way in which he coached me and others for the international work. Without his inspiring example I would never have received this Award.

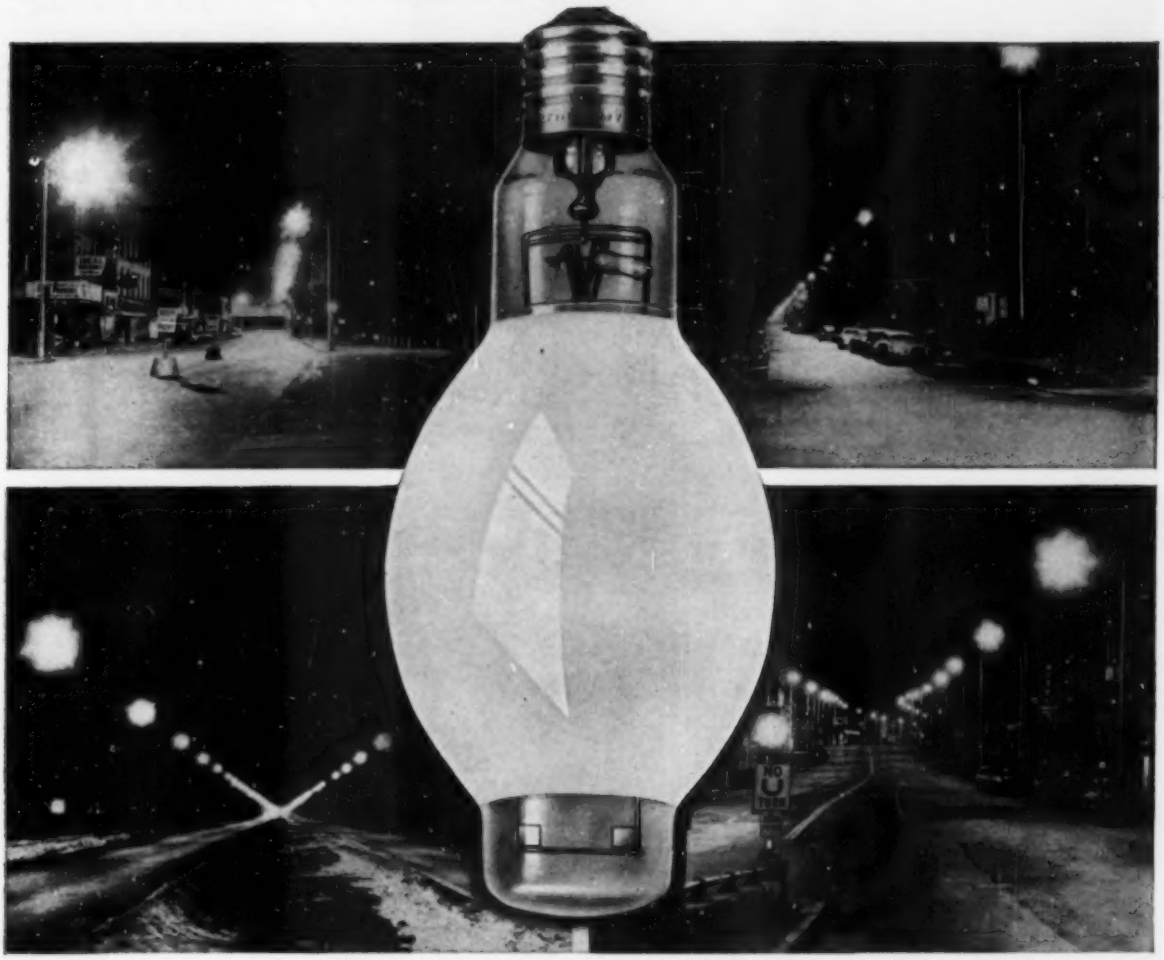
The honor I feel not to be entirely for myself. I regard it also as a token of your appreciation for CIE.

The United States National Committee has always shown great interest in its work, and large American Delegations have attended the Sessions notwithstanding the considerable distances they have had to travel.

Your Society has a special award, the "travel gavel," for that Section with the largest number of members present at a National Technical Conference in percentage of "total membership times distance travelled." If the International Commission on Illumination had such a travel gavel, it would certainly go to the U. S. Delegation.

Mr. President, may I end by repeating—I am deeply grateful for the honor your Society conferred upon me.

FROM HIGHWAY TO SIDE STREET . . .



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Sylvania *"Ruggedized"* Mercury Lamps

provide more light—longer—save money!

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- **9000 HOURS AVERAGE USABLE LIFE.** You get the equivalent of two years' street lighting service.
- **RUGGEDIZED GLASS** to resist moisture, condensation, thermal shock.
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- **SYLVANIA'S EXCLUSIVE LIFE RECORDING BASES** are numbered to show month and year that lamp was installed.
- **GUARANTEED PERFORMANCE.** Free exchange on any lamps which burn out during the first 1000 hours.

Sylvania offers, free, the services of its staff of lighting engineers to help evaluate your present and future lighting requirements. *For complete information or literature call your Sylvania Representative or write:*

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Subsidiary of
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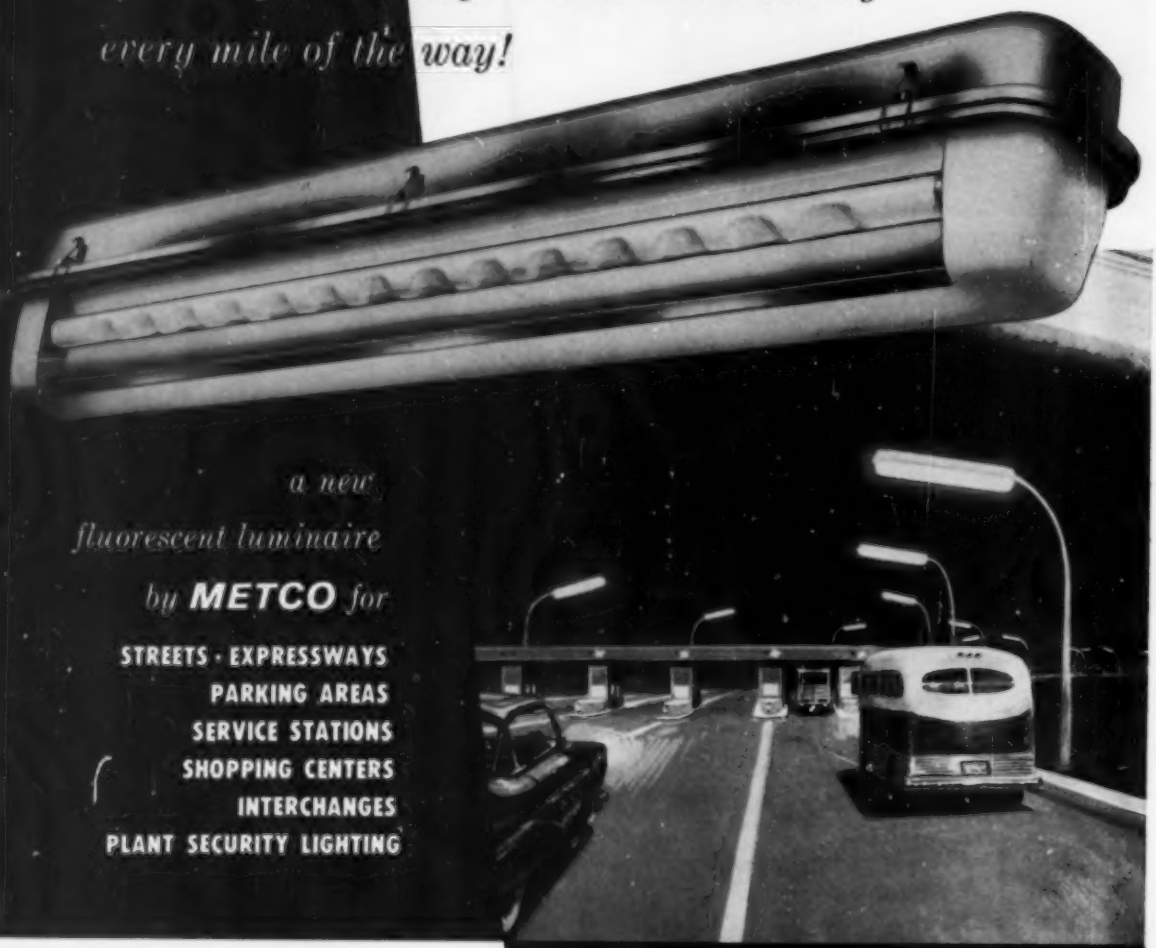
BROADSTREETER

turns night into day . . . with real economy every mile of the way!



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General Sarnoff Medal Established by AIEE

Establishment of the General David Sarnoff Medal in electronics has been announced by the American Institute of Electrical Engineers. Announcement was made by J. H. Foote, AIEE President, at an October 7th dinner meeting in Philadelphia. Occasion for the meeting was a celebration of the 75th Anniversary of AIEE and commemoration of its first technical meeting, held in Phiiladelphia on October 7, 1884.

Initial presentation of the Medal, made possible with the cooperation of the Radio Corp. of America, will be made at the Fall General Meeting of AIEE in Chicago in 1960.

The first striking of the Medal was presented to General Sarnoff, Chairman of the Board of RCA, by Mr. Foote.

READY to break ground for United Engineering Center, New York, are former President Herbert Hoover and Jerry Fujimoto, Hawaiian-born freshman at Rensselaer Polytechnic Institute, Troy, N. Y. At right is Andrew Fletcher, President of the United Engineering Trustees, who will own and operate the building; at left, J. H. Foote, President of AIEE. Surrounding the ground breakers are Presidents of some of the engineering societies which will occupy the building. In the background—some of the hardy spectators.

Ground Breaking Ceremonies for United Engineering Center

Despite the rains and winds which Hurricane Gracie brought to New York City on October 1, the ground breaking ceremonies for the United Engineering Center were carried on as planned. In a symbolic linking of the past and future of engineering, former President Herbert Hoover and Jerry Fujimoto, Hawaiian-born, freshman engineering student at Rensselaer Polytechnic Institute, Troy, N. Y., turned the first spadefuls of earth on the construction site.

The 18-story building on United Nations Plaza, scheduled for completion in 1961, will house the headquarters of 18 major engineering societies representing 300,000 members. Office space, meeting rooms for 400 people, small conference rooms, an exhibit area, cafeteria and expanded facilities for the Engineering Societies Library will be provided in the center.

Speaking at the ground breaking ceremonies, in addition to Mr. Hoover, were Andrew Fletcher, President of the United Engineering Trustees, who will own and operate the Center on behalf of the Societies; Willis F. Thompson, Wescott and Mapes, Inc., New Haven, Conn., Chairman of the Real Estate Committee; R. E. Dougherty, Chairman of Member Gifts Committee, and Mervin Keily, retired President of Bell Telephone Laboratories. Guests on the speakers' platform included Presidents of the Societies which will occupy the building, among them IES President Joe B. Browder.

The eight-year fund raising campaign for the UEC has already achieved almost $5 million in contributions from industry and $3 million in individual member contributions. An additional $2 million is needed to make the center debt free.

About 500 hardy spectators watched the ceremonies, including seven representatives of IES: Past-President and Mrs. George J. Taylor (during whose administration most of the planning for IES participation in the Center was carried out); A. D. Hinckley, Managing Director; Ruby Redford, Editor; John E. Kaufman, Engineering Assistant; John K. Michel, Office Manager, and Barbara E. Marwell, Assistant to the Editor.

Architects, Consulting Engineers Attend Lighting Conference

A three-day lighting conference, keyed to the interests of architects and consulting engineers, was held at the General Electric Lighting Institute in Nela Park on October 28-30. Highlights of the meeting were discussions on the importance of the relationship between quantity of illumination and brightness quality in view of the higher footcandle levels recommended by IES, and the use of light as an element of design. A session on lighting and its effect on air conditioning proved to be another popular element of of the program.

In addition to these specialized topics, the group was given a basic introduction to illuminating engineering which covered such fields as light for vision, requirements of lighting design, lamps and design of lighting for specific areas.

Eta Kappa Nu Award to Outstanding Young Engineer

Dr. Edgar A. Sack, Jr., Westinghouse Electric Corp., Pittsburgh, Pa., has been named as the Outstanding Young Electrical Engineer of 1959 as a result of a nationwide talent search conducted by Eta Kappa Nu, the national electrical engineering honor society. Honorable mention awards were to William O. Fleckenstein, Bell Telephone Laboratories, Inc., Whippany, N. J.; Kenneth H. Olsen, Digital Equipment Corp., Bedford, Mass., and John W. Wentworth, Radio Corp. of America, Haddonfield, N. J. Formal presentation of the awards will be made during the Winter General Meeting of AIEE in New York City in February.

At the age of 29, Dr. Sack has already contributed much to the field of solid state device research and development. His initial achievement was a contribution to the understanding of dielectric amplifiers through his doctoral research in connection with ferro-electric materials and their use in resonant dielectric amplifiers. More recently, he has been responsible for advances in electroluminescence and the application of this principle to practical solid state display mechanisms. His work has made possible an electroluminescent alpha-numeric and digital indicator and high resolution mi-

(*Continued on page* 30A)

(Continued from page 29A)

crocircuit structures for flat panel mural television displays, valuable for Navy command information centers. Dr. Sack also supervised the design and installation of the first full-scale application of electroluminescent panels to room lighting, in 1956.

The 1959 Outstanding Electrical Engineer Award is the twenty-fourth in a series which began in 1936. Selection of Dr. Sack as 1959 winner was made by a Jury of Award composed of leaders of the engineering profession — Chairman, Ernst Weber, President, Polytechnic Institute of Brooklyn, and President, Institute of Radio Engineers; J. B. Browder, President, Illuminating Engineering Society; Larry Dwon, Past-President, Eta Kappa Nu; L. C. Holmes, Vice-President, ITT Laboratories, Inc., A. Naeter, President, Eta Kappa Nu, and C. V. Roseberry, Vice-President, Westinghouse Electric Corp.

Russian Power Experts Tour U.S. Electrical Facilities

During the month of October, a team of 12 power specialists from the Soviet Union toured electric power systems and equipment manufacturing plants in the United States. The tour was made under the sponsorship of the Edison Electric Institute and the Association of Edison Illuminating Companies.

The Russian group, headed by K. S. Lavrenenki, First Deputy Minister of Electric Power Station Construction, visited installations in New York; Newark, Philadelphia; Washington, D. C.; Detroit, Philo, Ohio; Cleveland; Denver and Los Angeles. The tour included conventional steam and hydroelectric facilities, as well as two nuclear power plants and factories manufacturing heavy electrical equipment.

This visit was part of a technical and cultural exchange program between the United States and the USSR. Ten United States electrical industry executives spent two weeks this summer touring power facilities in Siberia, the Urals and Armenia, following a two-week tour in the summer of 1958 of European Russian facilities.

New Jersey Section Basic Lighting Course

Initial "Fundamentals of Illumination" course conducted under the auspices of the New Jersey Section of IES held its first meeting on October 13, 1959. The course, scheduled for 12 sessions extending through January 19, 1960, was designed with an emphasis on calculation of the new illumination levels, selection and layout of luminaires and basic floodlighting calculations. Practice sessions on problems of filament, fluorescent and mercury lighting and luminous ceiling systems have also been planned.

Classes meet in the sales classrooms of the Public Service Electric & Gas Co. in Newark, N. J. Coordinator for the course is Walter S. Greenwood, Public Service Electric & Gas Co., and faculty is composed of Priscilla Presbrey and J. L. Kaswan, Westinghouse Electric Corp.; F. C. Infanger, General Electric Co.; R. V. Smith, Holophane Co., Inc.; H. C. Clum, Silvray Lighting, Inc.; W. C. Cummings, Jr., and Mr. Greenwood, Public Service Electric & Gas Co.

Scheduled program is:

October 13 — Theory of Light, Terminology, Measurements.
October 20—Light Sources—Filament Lamps.
October 27 — Light Sources — Fluorescent Lamps.
November 10—Light Sources—Mercury Lamps.
November 17—Control of Light—Fixture Distributions.
November 24—Principles of Lighting Design (Problems).
December 1—Application of Average Lumen Method (Problems).
December 8—Practice Session (Problems).
December 15—Practice Session (Problems).
January 5—Floodlighting and Point-by-Point Calculations (Problems).
January 12—Quality and Quantity of Lighting (Problems).
January 19 — Luminous Ceilings and High Footcandle Design (Problems).

Revised National Electrical Code Approved by ASA

The latest revision of the American Standard National Electric Code, C1-1959, has received the approval of the American Standards Association. The Code will be published by the National Fire Protection Association and, in a pocket edition, by the National Board of Fire Underwriters.

The National Electrical Code was originated in 1897 to set up minimum requirements necessary for safety in the use of electricity for light, heat, power and radio signals, primarily in buildings. The last revision was made in 1956.

Copies of the revised Code will soon be available from the publishing organizations as well as from ASA.

"Stability of Plastics" Conference Set for Washington, D. C.

The Baltimore-Washington Section of the Society of Plastics Engineers, Inc., in conjunction with the Prevention of Deterioration Center of the National Academy of Sciences, has scheduled a one-day regional technical conference on the "Stability of Plastics." The meeting will be held on December 1, 1959, in the auditorium of the National Academy of Sciences Building in Washington, D. C.

Purpose of the conference is to present a program covering concepts of mechanisms governing natural and synthetic polymer stability and degradation. Degradation under conditions of mechanical processing, ultraviolet and other radia-

(Continued on page 32A)

SUSTAINING Membership certificate presented to A. S. J. Steel (second from right), Public Utility District No. 1, Snohomish County, Everett, Wash., by Jack H. Wells, Chairman of IES Puget Sound Section. Pleased onlookers are F. C. Scharr (far left), Chairman of the Section's Sustaining Membership Committee, and Kermit Miller, Commercial Manager of Public Utility District No. 1.

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Extruded plastic prismatic lens panels provide flat surfaces and extra sharp edges. A pleasant, even diffused lighting effect is the result.

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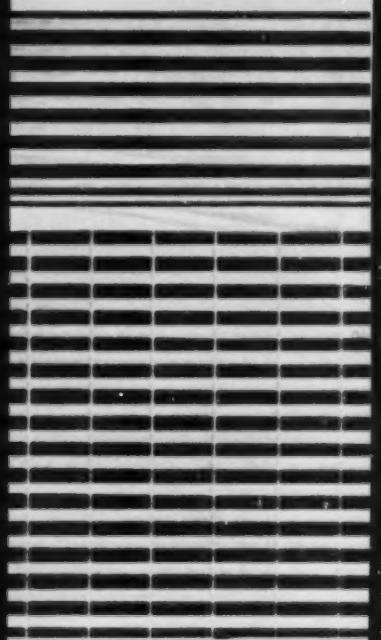

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(Continued from page 30A)

tion exposure, elevated temperatures and enzymatic attack will be among the topics covered.

Dr. Herman Mark, Director of the Polymer Research Institute, Polytechnic Institute of Brooklyn, N. Y., will moderate the conference.

Registration fee of $10 ($7.50 for government employees) includes a copy of a book containing comprehensive summaries of papers presented. Advance registration and hotel accommodations are available from Stanley Prosen, Naval Ordnance Laboratory, White Oak, Silver Spring, Md.

U. of Wisconsin Sponsors Executive Development Seminar

A two-day seminar on the development of executive abilities in engineers was held at the University of Wisconsin, Madison, Wis. Sponsoring the program was the Engineering Institute of the University's Extension Division.

Subjects discussed at the seminar included management philosophy, responsibilities of engineering executives, principles of self development and effective communication. The communications sessions were conducted in a "workshop" format, allowing ample opportunity for active participation by the registrants.

Other seminars planned by the Engineering Institute in its program to help prepare engineers for executive positions include: Industrial Adhesive Applications, Advances in Plastics Molding Technology, Drafting Management, Machine Shop Estimating, Basic Engineering Refresher Course and Industrial High Speed Photography.

Awards Announced for 1958-59 Membership Campaign

The presentation of a plaque to the Canadian Region, during ceremonies at the National Technical Conference in San Francisco, climaxed the IES Membership Committee's 1958-1959 campaign. Prize plaque, bearing the inscription "Awarded to the Canadian Region for outstanding performance in the National Membership Campaign," was accepted by Regional V-P J. Carl Wilson (see cut, page 17A) at the banquet.

Final results of the nationwide campaign, in each of its three divisions, are:

Region vs. Region	Per Cent Increase
Canadian	20.9
South Pacific Coast	15.0
South Central	9.7

Section vs. Section	Per Cent Increase
San Diego	62.0
Western New York	38.4
British Columbia	25.0
Miami Valley	21.9
New Jersey	20.8

Chapter vs. Chapter	
Quebec	139.0
Yosemite	64.0
San Jose	63.4
Winnipeg	47.3
Chinook	39.2

Cash prizes of $10 each will be presented to the San Diego Section and Quebec Chapter for top ranking in the national competition. In each of the 11 Regions, prizes of $15, $10 and $5 will be awarded to Sections and Chapters for first, second and third place in the Region. These presentations will be made at local meetings by the Regional Vice-Presidents.

Obituaries

Richard E. Simpson, Fellow and Member Emeritus of IES, died on September 19 at his home in West Hartford, Conn., after a long illness. He was 74.

Mr. Simpson was a well-known and respected authority on lighting and safety, particularly in the field of street lighting. His activities and studies in this area led to the publication of numerous technical articles in the *Transactions of the Illuminating Engineering Society* and other professional journals. In addition, he was the author of two books, *Illumination* and *Safety in Coal Mining*.

He was graduated from Yale University in 1905 and began his professional career at the Illuminating Engineering Laboratories of the General Electric Co. in Schenectady, N. Y. Later he joined the Travelers Insurance Co., where he served as a lighting and safety engineer for 20 years. Following this, Mr. Simpson served as a consulting engineer to such groups as the Connecticut State Highway Commission, Connecticut War Council, several Connecticut public utilities and Electrical Testing Laboratories.

Mr. Simpson joined IES in 1913 and transferred to Member grade in 1915. He gave long and valuable service to the Society as a member of the Street and Highway Lighting Committee from 1936-1951; member of the Motor Vehicle Committee; Research Coordinating Committee and Chairman of the Task Committee on President's Highway Safety Conference in 1945-1946. For many years, he was the Official IES Representative to the ASA Sectional Committee on Building Exit Codes, the Highway Research Board of the National Research Council and the American Society of Safety Engineers. He was a member of the U. S. National Committee of CIE from 1944-1946 and the IES Local Representative in Hartford, Conn., from 1936-1941.

In recognition of his service to IES and the illuminating engineering profession, Mr. Simpson was elected a Fellow of the Society in 1946. Upon his retirement in 1951 he was awarded the grade of Member Emeritus.

J. H. Kliegl, co-developer of the klieg light, used for taking motion pictures indoors, died on October 1 in New York City at the age of 89.

With his younger brother Anton, who died in 1928, Mr. Kliegl founded the Kliegl Brothers Universal Stage Lighting Co. in 1896. At the time of his death, he was President of the company.

In addition to the development of the klieg light, one of the first carbon arc lamps, Mr. Kliegl was connected with the design and installation of the first incandescent lighting system in the Metropolitan Opera House and supplied stage lighting for such theatrical notables as George M. Cohan, David Belasco and Mrs. Minnie Maddern Fiske.

Mr. Kliegl was born in Bad Kissingen, Bavaria, in 1870 and came to the United States in 1888. He studied electricity at night and went to work for the Myerhofer Electric Stage Lighting Co. In 1896 Mr. Kliegl and his brother purchased this company and changed its name.

IES Fellows

With the election of eight new Fellows (see September IE, page 5A), the list of living IES Fellows, by Section and Chapter, including year elected, is as follows:

ALAMO SECTION

DARLEY, WILLIAM G. (1948), Consulting Engineer, 164 USAA Building, P.O. Box 6743, San Antonio, Texas.

HARMON, DARELL B. (1947), Texas State Department of Health, Austin, Texas.

BUCKEYE CHAPTER

FRANCK, KURT (1954), Holophane Company, Inc., Newark, Ohio.

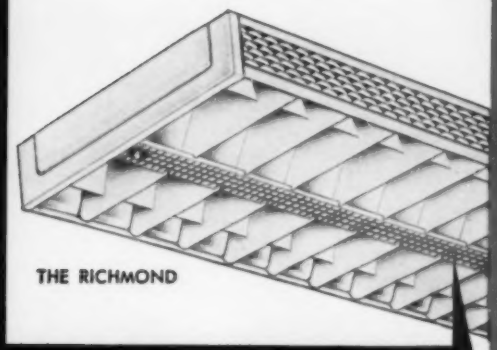
FRY, GLENN A. (1953), Ohio State University, Columbus, Ohio.

CAPITAL SECTION

BARROW, LOUIS E. (1955), National Bureau of Standards, Washington 25, D. C.

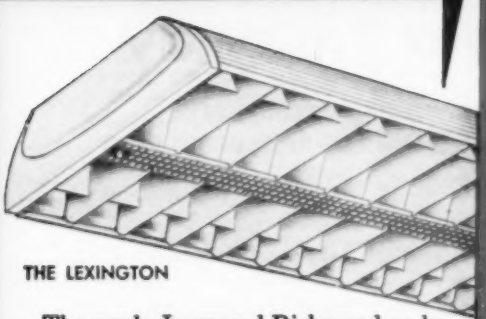
BRECKENRIDGE, FRANCIS C. (1949), National Bureau of Standards, Washington 25, D. C.

(Continued on page 35A)



THE RICHMOND

New Fixture Values... The IMPROVED RICHMOND and LEXINGTON by Miller ...with these installation and maintenance exclusives



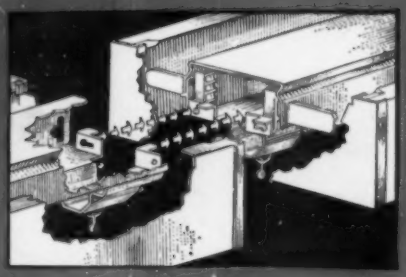
THE LEXINGTON

The newly Improved Richmond and Lexington Series by Miller offer outstanding Values for lighting Schools, Offices, and Stores.

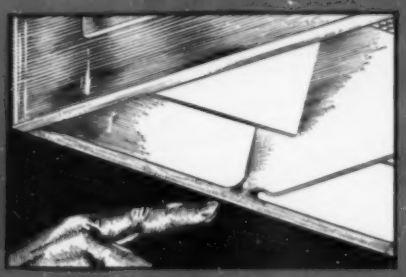
Four exclusive installation and maintenance features have been built into all units in both series. *Prices for most types are at new lows*, while illumination performance remains high as ever. And, these new fixture groupings have an even trimmer, more modern appearance.

You can choose between 45°x45° or 35° x 25° shielding for both series; 2 or 4 Lp., 40W Rapid Start or 8 ft. Slimline. 2 Lp. Richmonds and Lexingtons also available for 800 MA High Output lamps. *Power-Groove* operation is a brand new option for the 2 Lp. Richmond.

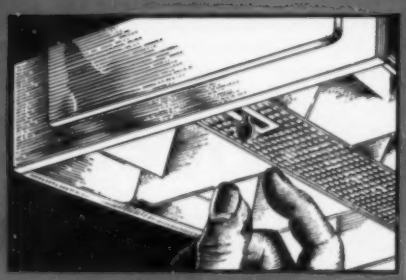
For complete catalog information write Dept. RL-119. For a physical demonstration of these outstanding fixtures, contact your local Miller Representative.



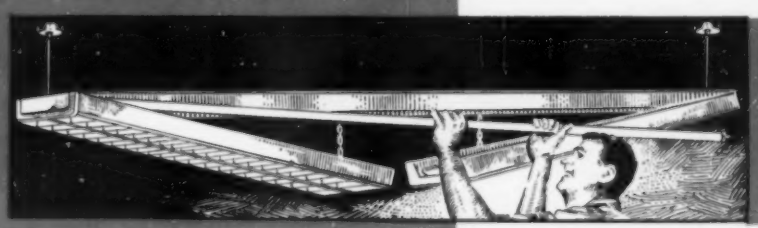
Easy channel connection and accurate horizontal alignment assured by built-in key slot connector and aligning tabs.



Sturdy, one piece cross louver construction assures rigid, rattle free shielding assembly.



Shielding assembly is securely locked in position (or lowered on safety chains) by quarter turn of visual action thumb latches.



Suspended 8 Ft. units can be easily relamped from single ladder position.

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LIGHTING BY
miller
SINCE 1844

INSTALLATION of Line Material Uni-Ballast systems provides power for the Ovalite mercury vapor luminaires at the two largest interchanges on the Olympia Freeway.

NIGHT VIEW of a most important interchange, this "off ramp" provides direct access to the Capitol, Olympia, Wash. Ample light makes these interchanges safe for night traffic.

L-M Lighting Provides Economical Solution on New Olympia Freeway

Cost of original equipment plus installation and operating economies were prime considerations in choosing L-M's exclusive Uni-Ballast(TM) series system and L-M Ovalite(TM) mercury vapor luminaires.

The newly constructed and recently opened Olympia Freeway provides a beautiful, safe artery for traffic flowing to and from the Capitol Building at Olympia, Washington. In addition, a five-mile section of primary State Highway No. 9 has also been opened to traffic. Both are built to modern freeway standards and since they are primarily in-town highways, many interchanges have been provided.

Chose L-M "Ovalite" . . . These modern thruways have been made as beautiful and safe at night as they are by day, through well-designed, well-located highway lighting. All interchanges have high-intensity lighting to assure the utmost in safety. Fill-in lighting is used in all areas where ramp connections are within 600 feet of each other. The Washington State Highway Department chose L-M horizontal-burning Ovalite mercury vapor luminaires mounted on spun-aluminum poles for this most essential lighting.

Series System at Interchanges . . . At two of the largest interchanges, the Freeway tie-in to the Capitol Building and the junction of the Freeway and Highway No. 9, the problem of supplying power to individual light standards was encountered. Because of the distances involved, a series power supply proved to be the only practical way to keep copper sizes down, and keep costs within reasonable limits.

"Uni-Ballast" System Cuts Costs . . . After careful analysis of both installation and operating economies of all available series lighting equipment, the Highway Department decided upon Line Material's exclusive Uni-Ballast system. The Uni-Ballast system is a constant current series system designed by L-M for mercury vapor lamps. This system completely eliminates the necessity of individual ballasts at each luminaire, allowing substantial savings.

L-M Lighting Application Engineering . . . The lighting of these modern expressways is typical of the many installations of L-M lighting equipment. With a complete line of outdoor lighting equipment and a qualified staff of Lighting Engineers anxious to work with you, Line Material can help you arrive at economical solutions of most of your lighting problems.

Get Complete Information . . . For complete information on the L-M Ovalite, the exclusive Uni-Ballast system, or all L-M outdoor lighting equipment ask your L-M Field Engineer or Lighting Engineer; or write Line Material Industries, Outdoor Lighting Division, Milwaukee 1, Wisconsin. In Canada: Canadian Line Materials, Division of McGraw-Edison Company (Canada), Limited, Toronto 13, Ontario. 417

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LINE CONSTRUCTION MATERIALS • PORCELAIN INSULATORS • FIBRE PIPE AND CONDUIT

McGRAW EDISON

(Continued from page 32A)

CLEAVER, OSCAR PAYNE (1946), Engineer Research & Development Lab., Ft. Belvoir, Va.

GIBSON, KASSON S. (1954), 4817 Cumberland Ave., Chevy Chase 15, Md.

NICKERSON, DOROTHY (1956), U. S. Dept. of Agriculture, Cotton Div., AMS, Washington 25, D. C.

PEARSON, H. J. C. (1953), Duke Ave. Argyle Heights, Fredericksburg, Va.

TEELE, RAY P. (1957), National Bureau of Standards, Washington 25, D. C.

CENTRAL NEW YORK SECTION

COTTRELL, CASPER L. (1955), Cornell University, Phillips Hall, Ithaca, N. Y.

STRONG, EVERETT M. (1952), Cornell University, Phillips Hall, Ithaca, N. Y.

CHICAGO SECTION

BENSON, BENJAMIN S., JR. (1955), Benjamin Electric Mfg. Co., Des Plaines, Ill.

CHURCH, ERIC H. (1956), Lighting Products Inc., 1549 Park Ave. W., Highland Park, Ill.

FOULKS, WILLIAM V. C. (1952), Curtis Lighting Inc., 6135 W. 65th St., Chicago 38, Ill.

HARDACRE, GILBERT K. (1956), Public Service Co., Div. of Commonwealth Edison Co., 51 W. Jackson St., Joliet, Ill.

HJERMSTAD, HANS U. (1958), Sola Electric Co., 4633 W. 16th St., Chicago 50, Ill.

JAMES, LEONARD V. (1947), Illuminating Engineering Consultant, 513 S. Catherine Ave., La Grange, Ill.

STAIR, J. L. (1945), 1734 E. 72nd St., Chicago 49, Ill.

TILLSON, EDWIN D. (1945), 2507 Lincoln St., Evanston, Ill.

ZERSEN, CARL W. (1953), Chicago Lighting Institute, 140 S. Dearborn St., Chicago 3, Ill.

CLEVELAND SECTION

ALLEN, CARL J. (1958), General Electric Co., Lamp Division, Nela Park, Cleveland, Ohio.

BARR, ARTHUR C. (1955), General Electric Co., Nela Park, Cleveland 12, Ohio.

BAUMGARTNER, GEORGE R. (1953), General Electric Co., Nela Park, Cleveland, Ohio.

BROWN, WILLARD C. (1945), General Electric Co., Nela Park, Cleveland 12, Ohio.

CUTLER, C. M. (1952), General Electric Co., Nela Park, Cleveland 12, Ohio.

DORSEY, ROBERT T. (1959), General Electric Co., Nela Park, Cleveland, Ohio.

DOWNES, ARTHUR C. (1947), 2181 Niagara Drive, Lakewood 7, Ohio.

EGELER, C. E. (1954), 1078 Brandon Road, Cleveland 12, Ohio.

FORSYTHE, W. D. (1947), 15006 Terrace Road, Cleveland 12, Ohio.

GUTH, SYLVESTER K. (1953), General Electric Co., Nela Park, Cleveland 12, Ohio.

HARRISON, WARD (1945), 23475 Stanford Road, Cleveland 22, Ohio.

HORTON, G. A. (1956), Westinghouse Electric Corp., 1216 W. 58th St., Cleveland 1, Ohio.

KAHLER, WILLIAM H. (1953), Westinghouse Electric Corp., 1216 W. 58th St., Cleveland 1, Ohio.

KETCH, JAMES M. (1950), 991 Roanoke Road, Cleveland 21, Ohio.

LINSDAY, E. A. (1959), General Electric Co., Nela Park, Cleveland 12, Ohio.

LOZIER, W. WALLACE (1957), National Carbon Research Labs., P.O. Box 6116, Cleveland 1, Ohio.

LUCKIESH, MATTHEW (1945), 21175 Shaker Blvd., Shaker Heights, Cleveland, Ohio.

MAGDSICK, H. H. (1945), 15925 Van Aken Blvd., Shaker Heights, Cleveland, Ohio.

(Continued on page 36A)

SCHEDULED EVENTS

November 17-19, 1959—Building Research Institute (Fall Conferences), Shoreham Hotel, Washington, D. C.

November 18-20, 1959—National Electric Farm Power Conference, Hotel Westward Ho, Phoenix Ariz.

November 19, 1959—Council Meeting, Illuminating Engineering Society, New York, N. Y. Members are free to attend meetings of Council as guests.

November 29-December 4, 1959—The American Society of Mechanical Engineers, Chalfonte-Haddon Hall, Atlantic City, N. J.

January 12-15, 1960—The Society of Plastics Engineers, Inc., 16th Annual Technical Conference, The Conrad Hilton Hotel, Chicago, Ill.

January 25-28, 1960—Plant Maintenance Show, Convention Hall, Philadelphia, Pa.

January 31-February 6, 1960—American Institute of Electrical Engineers, Winter General Meeting, New York, N. Y.

February 11, 1960—Council Meeting, Illuminating Engineering Society, New York, N. Y. Members are free to attend meetings of Council as guests.

February 22-25, 1960—National Rural Electric Cooperative Association (Annual Meeting), St. Louis, Mo.

February 25-26, 1960—Annual National Wiring Sales Conference, Warwick Hotel, Philadelphia, Pa.

March 6-9, 1960—Fifth Electrical Industries Show, New York City Coliseum, New York, N. Y.

March 23-26, 1960—Tenth Electrical Industry Show and Lighting Exposition, Shrine Exposition Hall, Los Angeles, Calif.

April 5-7, 1960—Building Research Institute, Spring Conferences, Statler-Hilton Hotel, New York, N. Y.

April 11-12, 1960—Inter-Society Color Council, Philadelphia Museum College of Art, Philadelphia, Pa.

April 21-22, 1960— South Central—Southeastern Regional Conference, IES, Hotel Peabody, Memphis, Tenn.

April 25-26, 1960—Southwestern Regional Conference, IES, Robert Driscoll Hotel, Corpus Christi, Texas.

April 28-29, 1960—Inter-Mountain Regional Conference, IES, Hotel Westward Ho, Phoenix, Ariz.

May 1-5, 1960—National Association of Electrical Distributors, Dallas, Texas.

May 4-5, 1960—South Pacific Coast Regional Conference, IES, Ambassador Hotel, Los Angeles, Calif.

May 9-10, 1960—Pacific Northwest Regional Conference, IES, Benjamin Franklin Hotel, Seattle, Wash.

May 10-12, 1960—American Institute of Electrical Engineers (Farm Electrification Conference), Sheraton-Fontenell Hotel, Omaha, Nebr.

May 12-13, 1960—Midwestern Regional Conference, IES, Sheraton Martin Hotel, Sioux City, Ia.

May 16-17, 1960—Great Lakes Regional Conference, IES, Hotel Carter, Cleveland, Ohio.

May 23-26, 1960—Design Engineering Show, Coliseum, New York, N. Y.

June 8-9, 1960—Northeastern Regional Conference, IES, Wentworth-by-the-Sea, Portsmouth, N. H.

June 13-14, 1960—Canadian Regional Conference, IES, Nova Scotian Hotel, Halifax, N. S.

June 16, 1960—Council Meeting, Illuminating Engineering Society, New York, N. Y. Members are free to attend meetings of Council as guests.

August 8-12, 1960—American Institute of Electrical Engineers, Pacific General Meeting, San Diego, Calif.

September 6-16, 1960—Production Engineering Show, Navy Pier, Chicago, Ill.

September 11-16, 1960—Illuminating Engineering Society, National Technical Conference, Penn-Sheraton Hotel, Pittsburgh, Pa.

September 28-30, 1960—Canadian Electrical Manufacturers Association, Sheraton-Brock Hotel, Niagara Falls, Ont.

October 9-14, 1960—American Institute of Electrical Engineers, Fall General Meeting, Chicago, Ill.

October 23-27, 1960—National Electrical Contractors Association, Las Vegas, Nevada.

November 14-18, 1960—National Electrical Manufacturers Association (Annual Meeting), Traymore Hotel, Atlantic City, N. J.

(Continued from page 35A)

PENNOW, WILLIS A. (1955), Westinghouse Electric Corp., 1216 W. 58th St., Cleveland 1, Ohio.

POTTER, WENTWORTH M. (1953), General Electric Co., Nela Park, Cleveland 12, Ohio.

PUTNAM, RUSSELL C. (1948), Case Institute of Technology, Cleveland 6, Ohio.

REID, KIRK M. (1948), General Electric Co., Nela Park, Cleveland 12, Ohio.

RODGERS, ALSTON (1957), General Electric Co., Nela Park, Cleveland 12, Ohio.

ROPER, VAL J. (1949), General Electric Co., Nela Park, Cleveland 12, Ohio.

ROWTEN, DANA W. (1957), Westinghouse Electric Corp., 1216 W. 58th St., Cleveland, Ohio.

STURROCK, WALTER (1946), 15002 Terrace Rd., E. Cleveland 12, Ohio.

THAYER, RICHARD N. (1958), General Electric Co., Cleveland, Ohio.

WEITZ, C. E. (1955), 1848 Hillside Rd., E. Cleveland 12, Ohio.

WAKEFIELD, GEORGE P. (1952), The Wakefield Co., Vermilion, Ohio.

WEBBER, MARY E. (1955), General Electric Co., Nela Park, Cleveland 12, Ohio.

WEITZ, C. E. (1955), 1848 Hillside Rd., E. Cleveland 12, Ohio.

WINKLER, FREDERIC C. (1947), Westinghouse Electric Corp., 1216 W. 58th St., Cleveland 1, Ohio.

CONNECTICUT SECTION

BEALS, GILLSON W. (1953), The Miller Co., Meriden, Conn.

NEIDHART, JOHN J. (1954), The Miller Co., Meriden, Conn.

EASTERN NEW YORK

BOCK, JOHN E. (1952), 6 Irving Road, Scotia 2, N. Y.

FLORIDA SECTION

DICKERSON, A. F. (1945), 1455 Harbor Drive, Sarasota, Fla.

PRIDEAUX, GWILYM F. (1956), 528 15th Ave. S., Naples, Fla.

FOREIGN NON-SECTION

FARNSWORTH, DEAN, LT. COMDR. U.S.N.R. (1953), Office of Naval Research, Keysign House, 429 Oxford St., London, W. 1, England.

WALDRAM, J. M. (1952), Research Laboratories of General Electric Co., Ltd., Wembley, England.

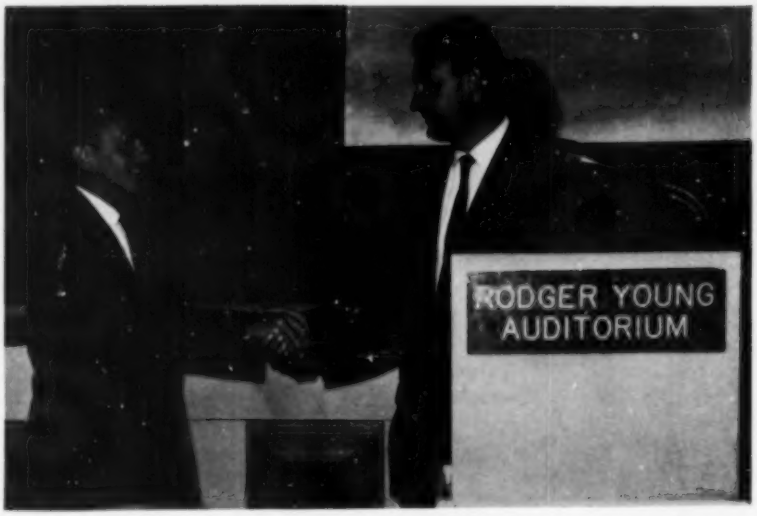
GOLDEN GATE SECTION

FINCH, DANIEL M. (1954), University of California, Berkeley, Calif.

WALSH, JOHN S. (1959), Pacific Gas & Electric Co., 245 Market St., San Francisco, 6, Calif.

MARYLAND SECTION

SHARP, HOWARD M. (1945), Box 217, Easton, Md.



Joe Platt (left), incoming Chairman of the Lamplighters, street lighting committee of Southern California Section, accepting congratulations from outgoing Chairman Roy Bevan at the group's first meeting of the 1959-1960 year. Among the speakers at this kick-off meeting were R. E. Faucett, General Electric Co., Hendersonville, N. C., and Warren Edman, Holophane Co., Inc., Newark, Ohio.

MICHIGAN SECTION

ANDERSON, EARL A. (1956), 19218 Berkeley Road, Detroit 21, Mich.

GOODELL, PAUL H. (1947), Catalytic Combustion Corp., 4544 Grand River, Detroit, Mich.

SCHRENK, L. J. (1952), City of Detroit, Public Lighting Commission, 174 Atwater St., Detroit 26, Mich.

WALL, HAROLD F. (1958), Public Lighting Comm., 174 E. Atwater St., Detroit, Mich.

MILWAUKEE SECTION

ILLING, I. L. (1947), 1754 Rocky Point Road, Pewaukee, Wis.

LAUPP, CHARLES N. (1956), Wisconsin Electric Power Co., 231 W. Michigan St., Milwaukee 1, Wis.

MOTHER LODE CHAPTER

GIBSON, CHARLES D. (1955), Bureau of School Planning, California State Dept. of Education, 721 Capitol Ave., Sacramento 14, Calif.

NEW ENGLAND SECTION

ALLPHIN, WILLARD (1950), Sylvania Electric Products, Inc., 60 Boston St., Salem, Mass.

BROWN, RICHARD B., JR. (1945), Boston Edison Co., 39 Boylston St., Boston, Mass.

HALVORSON, C. A. B. (1955), 25 Chestnut St., Salem, Mass.

JEROME, CHARLES W. (1957), Sylvania Electric Products, Inc., 60 Boston St., Salem, Mass.

LOWELL, WILLIAM P., JR. (1953), Sylvania Electric Products, Inc., 60 Boston St., Salem, Mass.

PARKER, ALLAN E. (1946), Worcester Polytechnic Institute, Worcester 2, Mass.

RADDIN, ELLERY H. (1952), Champion Lamp Works, 600 Broad St., Lynn, Mass.

NEW JERSEY SECTION

BEGGS, EUGENE W. (1952), 37 Hamilton Road, Glen Ridge, N. J.

BRUUN, SVEND W. (1958), Consulting Engineer, 420 Lexington Ave., New York 17, N. Y.

COX, JAMES L. (1958), Duro-Test Corp., 2401 Hudson Blvd., N. Bergen, N. J.

FREEMAN, GEORGE A. (1957), Westinghouse Electric Corp., Bloomfield, N. J.

HIBBEN, SAMUEL G. (1945), 31 Clinton Ave., Montclair, N. J.

JENSEN, BRUCE J. (1956), Public Service Electric & Gas Co., 80 Park Place, Newark, N. J.

TAYLOR, GEORGE J. (1953), Day-Brite Lighting, Inc., 122 E. 42nd St., New York 17, N. Y.

WATERMAN, MARSHALL N. (1956), Westinghouse Electric Corp., Bloomfield, N. J.

ZABEL, ROLLAND M. (1951), Westinghouse Electric Corp., Bloomfield, N. J.

ZAHOUR, ROBERT L. (1958), Westinghouse Electric Corp., Bloomfield, N. J.

NEW YORK SECTION

BERENS, CONRAD, (1946), Ophthalmologist, 111 E. 59th St., New York 22, N. Y.

(Continued on page 38A)

simplicity — the key to positive light seal

new Smithcraft SPEEDOMATIC TROFFERS

New Smithcraft Speedomatic troffers utilize the principle of the interlocking grip, the full length of the door frame, assuring positive light seal. There are no visible bolts, catches or hinges to mar the architectural beauty of new Speedomatic troffers. Framed in the ceiling by a single width of metal, new Speedomatic troffers offer maximum illuminated areas and long, free-flowing precise lines.

Today's most versatile troffer, the new Smithcraft Speedomatic is available in one- and two-foot wide widths, in an abundance of sizes and shieldings that add up to 5366 individual choices in one complete troffer line. This unique versatility allows the architect complete freedom of expression in lighting arrangements.

Specifying and ordering of Speedomatic is extremely simple — four basic types fit over 100 ceiling systems (as listed in Smithcraft's complete Ceiling Index).

For complete information on versatile, trim Speedomatic troffers, and Smithcraft's Ceiling Index, write for complete 30-page catalog and price list.

Smithcraft
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+ Light-conditioning by Smithcraft — America's finest fluorescent lighting

(Continued from page 36A)

BUTTOLPH, L. J. (1952), 1 Columbia Ave., Cliffside Park, N. J.

COOPER, BERLON C. (1959), McGraw-Hill Publishing Co., 330 W. 42nd St., New York, N. Y.

CROUCH, CAZAMER L. (1946), Illuminating Engineering Society, 1860 Broadway, New York 23, N. Y.

FAHSBENDER, MYRTLE (1954), Westinghouse Electric Corp., Bloomfield, N. J.

FERREE, GERTRUDE RAND (1952), Institute of Ophthalmology, Presbyterian Hospital, 635 W. 165th St., New York 32, N. Y

LITTLE, WILLIAM F. (1945), 75 Dalton Road, Yonkers 2, N. Y.

LOGAN, HENRY L. (1947), Holophane Co. Inc., 342 Madison Ave., New York 17, N. Y.

MCCANDLESS, STANLEY (1959), Century Lighting, Inc., 521 W. 43rd, New York, N. Y.

PRESBREY, PRISCILLA (1959), Westinghouse Electric Corp., Bloomfield, N. J.

RAMBUSCH, EDWARD V. A. (1952), Rambusch Decorating Co., 40 W. 13th St., New York, N. Y.

SALTER, ERNEST H. (1953), Electrical Testing Laboratories Inc., 2 East End Ave., New York 21, N. Y.

NORTH TEXAS SECTION

FOLSOM, WILLIAM E. (1952), Dallas Power & Light Co., 1506 Commerce St., Dallas 1, Texas.

OETTING, ROBERT L. (1954), General Electric Co., 6500 Cedar Springs Road, Dallas, Texas.

PALMETTO SECTION

REX, C. H. (1954), General Electric Co., Outdoor Lighting Department, Hendersonville, N. C.

PHILADELPHIA SECTION

BRAINERD, ARTHUR A. (1946), Star Route, Erwinna, Pa.

HALLMAN, ERIC B. (1953), Electric Service Mfg. Co., 17th & Cambria Sts., Philadelphia 32, Pa.

HOLMES, P. R. (1946), General Electric Co., 3 Penn Center Plaza, Philadelphia, Pa.

SHOEMAKER, GEORGE E. (1953), Philadelphia Electric Co., 211 S. Broad St., Philadelphia, Pa.

WESTERMAIER, FRANCIS V. (1945), 400 King's Highway East, Haddonfield, N. J.

PITTSBURGH SECTION

CLARK, GEORGE W. (1959), Sylvania Electric Products, Inc., One 48th St., Wheeling, W. Va.

SLAUER, RICHARD G. (1949), Sylvania Electric Products, Inc., One 48th St., Wheeling, W. Va.

PUGET SOUND SECTION

BAKEMAN, C. T. (1947), 4234 92 N.E., Bellevue, Wash.

ROCHESTER SECTION

EVANS, RALPH M. (1953), Eastman Kodak Co., 65 Kodak Park, Rochester 4, N. Y.

ROCKY MOUNTAIN SECTION

MCCULLOCH, JAMES H. (1957), Independent Testing Laboratories, 1928 14th St., Boulder, Colo.

ST. LOUIS SECTION

AMICK, CHARLES L. (1955), Day-Brite Lighting, Inc., 5411 Bulwer Ave., St. Louis 7, Mo.

BRADLEY, RICHARD D. (1959), Day-Brite Lighting, Inc., P.O. Box 141, St. Louis 66, Mo.

LEWIS, CARTER (1955), Union Electric Co., 315 N. 12th St., St. Louis 1, Mo.

SAN JOSE CHAPTER

BROWN, LELAND H. (1945), Illumination Laboratory, Stanford, Calif.

SOUTHEAST FLORIDA SECTION

COMMERY, EUGENE W. (1950), 315 Harbor Drive, Key Biscayne, Miami 49, Fla.

SOUTHERN CALIFORNIA SECTION

BOELTER, LLEWELLYN M. K. (1948), University of California, Dept. of Engineering, Los Angeles 24, Calif.

GRAVES, LESTER H. (1945), 33 Loma Media Road, Santa Barbara, Calif.

HAMEL, J. SAMUEL (1957), 1122 Rossmoyne St., Glendale 7, Calif.

JONES, J. ROY (1957), Westinghouse Electric Corp., 600 St. Paul Ave., Los Angeles, Calif.

ROLPH, THOMAS W. (1945), 1465 San Pasqual St., Pasadena 5, Calif.

SHEPHERD, THEODORE H. (1957), Dept. of Water & Power, P.O. Box 3669, Terminal Annex, Los Angeles 54, Calif.

SOUTHERN COLORADO SECTION

KRAEHENBUEHL, JOHN OTTO (1948), Colorado College, Colorado Springs, Colo.

TAR HEEL SECTION

PALMER, ROY A. (1954), Duke Power Co., Power Bldg., Charlotte, N. C.

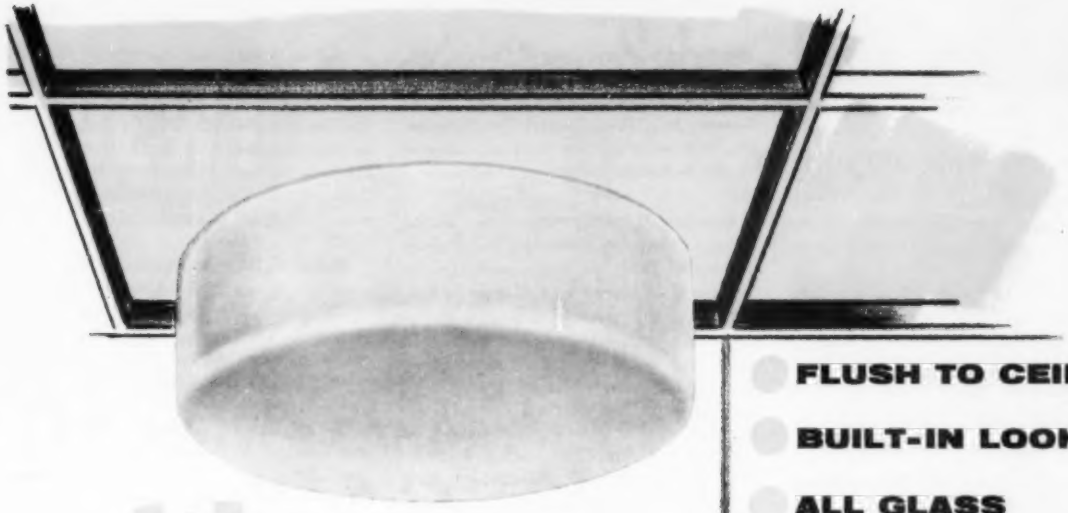
TORONTO SECTION

BATEMAN, JOSEPH W. (1953), Canadian General Electric Co., Ltd., 211 King St. W., Toronto, Ont.

(Continued on page 40A)

Howard Jasnau

Personally, I think it's a little too formal!



Klondike

by PERFECLITE

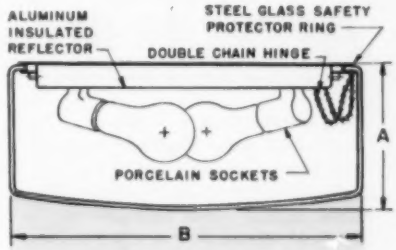
- **FLUSH TO CEILING**
- **BUILT-IN LOOK**
- **ALL GLASS**
- **ALL LIGHT**

No metal shows, nothing projects on the Klondike*, Perfeclite's latest incandescent ceiling unit. Mounted absolutely flush, it allows maximum utilization of the opal globe for the highest light efficiency available . . . gives that built-in look without costly recessing.

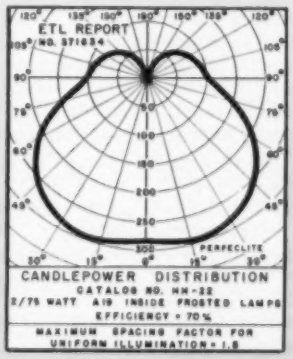
The globe opens on a double chain hinge for quick, easy cleaning and relamping . . . is secured in place again with a simple twist of the wrist by a unique patented locking device. Interior construction is of 20-gauge steel. The reflector is faced aluminum. The multiple porcelain sockets are equipped with #18 A F leads for direct connection to Types R, TW or any 60° C rated wire.

Here at last is a totally new concept in fixture design . . . a totally new way to provide better lighting for either commercial or residential interiors. For further information, mail the attached coupon today!

Units are Underwriters' Laboratories, Inc., approved.



Cat. No.	Wattage	A	B
HH-21	2-60W	5⅛"	10"
HH-22	2-75W	5⅝"	12"
HH-23	2-100W	6⅛"	14"
HH-24	3-100W	6⅝"	16"



CANDLEPOWER DISTRIBUTION
CATALOG NO. HH-22
2/75 WATT A19 INSIDE FROSTED LAMPS
EFFICIENCY = 70%
MAXIMUM SPACING FACTOR FOR UNIFORM ILLUMINATION = 1.8

*Patented

THE PERFECLITE COMPANY
1457 East 40th Street • Cleveland 3, Ohio

THE PERFECLITE COMPANY
1457 East 40th Street • Cleveland 3, Ohio
Please send me the Perfeclite Data Sheet 59-C.

NAME _____

ADDRESS _____

CITY _____ STATE _____

(Continued from page 38A)

CHORLTON, JOHN M. (1958), Toronto Board of Education, 155 College St., Toronto 2B, Ont.

DAVIDSON, HEDLEY F. (1958), Curtis Lighting of Canada Ltd., 195 Wicksteed Ave., Toronto, Ont.

DEAN, GEORGE FRANKLIN (1956), Toronto Hydro Electric System, 14 Carlton St., Toronto, Ont.

LOVE, ROBERT M. (1946), Canadian General Electric Co., Ltd., 940 Lansdowne Ave., Toronto, Ont.

MUDGETT, GUERNSEY F. (1946), Canadian Westinghouse Supply Co., Ltd., 195 Fleet St., E. Toronto, Ont.

TWIN CITY SECTION

JOHNSON, LAWRENCE E. (1959), Northern States Power Co., 15 S. 5th St., Minneapolis 2, Mnin.

ABOUT PEOPLE

Dr. **Harold Eugene Edgerton,** Professor of Electrical Measurement at the Massachusetts Institute of Technology, was presented with the Progress Medal Award, highest honor conferred by the Society of Motion Picture and Television Engineers. Award ceremonies took place during the Society's 86th Semi-Annual Convention, October 5-9, Statler-Hilton Hotel, New York City. Dr. Edgerton pioneered in the development of the stroboscope and the related electronic flash photographic equipment.

James H. Goss has been named Vice-President and Group Executive of the newly-established International Group of the General Electric Co., to which the G-E International Division has been assigned. In this position, Mr. Goss will act on behalf of the General Electric Co. with respect to its interests in and relations with the Canadian General Electric Co. Succeeding Mr. Goss as Vice-President and Group Executive for the Consumer Products Group is **Fred J. Borch.** Mr. Borch was formerly Vice-President for marketing services. **Charles K. Rieger,** former Vice-President and general manager of the Major Appliance Division, has been promoted to the marketing post.

G. R. Spriggs, Mount Vernon, N. Y., consultant for the C. S. Brainin Co., has been reelected chairman of the Electrical Contacts Section of the National Electrical Manufacturers Association. Mr. Spriggs was also chosen for a second term as chairman of the Section's Statistical Committee. **J. D. Klics,** Fansteel Metallurgical Corp., North Chicago, Ill., was reappointed as chairman of the Section's Standards Committee and **H. C. Graves, Jr.,** Gibson Electric Co., Delmont, Pa., will serve another term as chairman of the Industrial Relations Committee.

Sylvania Lighting Products, Salem, Mass., a division of Sylvania Electric Products, Inc., has announced the appointment of **Henry F. Callahan** as vice-president and general manager of the Division. Mr. Callahan had been vice-president—operations for Sylvania Lighting Products since January 1958. In his new capacity, he will be responsible for all activities of the Division. Also announced by Sylvania Lighting Products was the appointment of **Donald I. Coggins** as manager of commercial engineering for special products and photolamp sales. He has been associated with Sylvania since 1940, most recently as senior sales engineer. He is chairman of the Approach Lighting Subcommittee of the Aviation and Signal Committee of IES.

Professor **Harry W. Horn** has resigned from the Department of Electrical Engineering, University of Illinois, Urbana, Ill., to serve as research engineer in electrical power systems and illumination with Boeing, Wichita, Kans.

Westinghouse Lamp Division, Bloomfield, N. J., has announced the appointments of **Philip F. Dietz** as manager of the Rayescent (electroluminescent) Lamp Department and **Robert W. Wollentin** as research section manager in charge of applied research for the Lamp Division. Both men will make their offices at the Division's headquarters in Bloomfield.

Sola Electric Co., Chicago, Ill. has announced three new sales department appointments. **Richard J. Hesse** and **Joseph E. Warhola** were named as sales engineers for the New England and East Central districts, respectively, with headquarters in Boston, Mass. and Camden, N. J. **Donald Ingwersen** was assigned to the company's Lighting Division in Chicago.

Duro-Test Corp., North Bergen, N. J. has announced the appointment of **Alan D. Warren** as general sales manager of the Metropolitan Division. Mr. Warren, who has been associated with Duro-Test for the past nine years, was previously in the export business.

John R. Fritz, formerly an electrical engineer in charge of lighting design with Gilbert Associates, Reading, Pa., has joined the Radar and Missile Division of the Radio Corp. of America, Moorestown, N. J. The change in company affiliation also necessitated Mr. Fritz's resignation as Chairman-Elect of the Eastern Pennsylvania Section of IES. **R. A. Reynolds,** Crouse-Hinds Co., Philadelphia, Pa., will serve as Section Chairman for 1959-1960.

Roger S. Rogge has been named sales manager of the Illuminating Division of The Miller Co., Meriden, Conn. Mr. Rogge joined the company in 1947 as an application engineer and has served in various field assignments during the past 12 years. Immediately prior to his present appointment, Mr. Rogge was Central Regional Sales Manager with headquarters in Dearborn, Mich. As Illuminating Division sales manager, he will have his office at the company's headquarters in Meriden, Conn.

Hubbard and Co., Chicago, Ill., has appointed **Douglass S. List** as product manager to supervise the firm's new line of fuse cutouts. Mr. List will be headquartered at Hubbard's Melrose Park, Ill., plant. Prior to this appointment, he was with Duncan Electric, Lafayette, Ind., and more recently a manufacturer's representative in the Indiana-Kentucky area. Named as application engineer for the new line is **D. H. White,** formerly with the insulator department of General Electric Co. Other appointments at Hubbard include the following new field assignments for apparatus engineers: **Robert J. Green,** East Central Division; **S. Friend, Jr.,** Northeast Division and **Perry L. Bruton,** Southeast Division.

Edward J. White Co., Electrical Contractors, Newark, N. J., has announced the elections of **John J. Storminger** as President, **Edward J. White, II** as Vice-President and **Lucy Clarke,** Treasurer.

Thomas J. Evans was named Michigan lighting representative for the Edwin F. Guth Co., St. Louis, Mo. Mr. Evans succeeds **C. C. "Bill" Munroe** who died of a heart attack on August 17, 1959. Mr. Munroe had handled the Michigan territory for the past 15 years.

Compco Corp., Chicago, Ill., has appointed **Dan E. Dunne** as manager of its Mitchell Lighting Division, with headquarters in the company's home office in Chicago.

Phil M. Gandy has joined **H. C. King & Associates,** Cincinnati, Ohio, as sales representative for Day-Brite Lighting, Inc. Mr. Gandy will be responsible for the Charleston, West Virginia sales territory, which includes parts of eastern

(Continued on page 42A)

NEW!

Exclusive "Sales-Plus" *for you!*

Allegheny

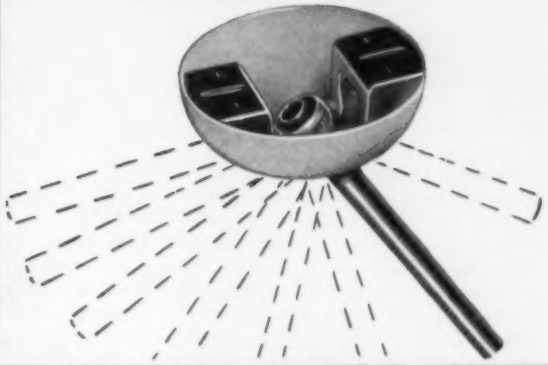
HANG STRAIGHT

45° SWIVEL CANOPY

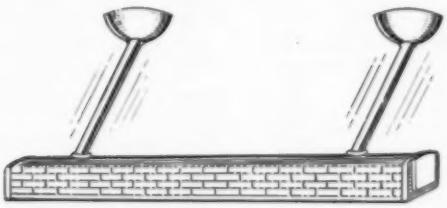
FOR

FLUORESCENT FIXTURES

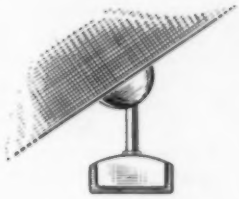
BALL-ACTION JOINT SWIVELS STEM ALL AROUND...UP TO 45° ANGLE!



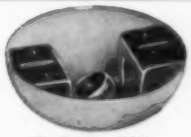
EARTHQUAKE, TORNADO AND HURRICANE PROOF! SAFER ACTION PREVENTS DANGER OF SNAP-OFF!



MAKES SLOPE OR SLANT CEILING INSTALLATIONS EASY! FIXTURE HANGS PERPENDICULAR TO FLOOR!



Model No. 575



Model No. 565

New Allegheny 45° Hang Straight Swivel Canopy available unfinished or with canopy electrostatically finished in white, yoke and ball cadmium plated. Choice of Model No. 575 with flash plate or Model No. 565 without flash plate.

Earthquake Approved by School Boards of California! New Allegheny Hang Straight 45° Swivel Canopy gives you a powerful "sales plus" in areas where flexible attachment of fluorescent ceiling fixtures is required. Gives you the perfect answer for the multitude of new slant ceiling installations in plants, schools, hospitals and institutions, too! See how it can help you increase sales and profits now! Write today!

Allegheny
Serving Industry Since 1925

WRITE TODAY for sample and prices!

Allegheny

STEEL & BRASS CORP.

1212 NORTH CENTRAL PARK AVENUE

CHICAGO 51, ILLINOIS

ALLEGHENY Steel & Brass Corp.

1212-14 N. Central Park Ave., Chicago 51, Illinois

Yes! I want a sample of the new Allegheny Hang Straight 45° SWIVEL CANOPY and a complete list of prices.

NAME_____

FIRM_____

ADDRESS_____

CITY_____ ZONE____ STATE_____

(Continued from page 40A)

Kentucky and southern Ohio. He will make his headquarters in Charleston, W. Va.

The Light & Power Utilities Corp., Memphis, Tenn., will open a second plant next spring in Olive Branch, Miss., according to an announcement by **Murray Reiter,** president of the fixture manufacturing firm. The new factory will be located 28 miles from the company's present site.

John W. Ferree, M.D. has been named executive director of the National Society for the Prevention of Blindness, according to a recent announcement by **Ira V. Hiscock,** president of the Society. The appointment was effective September 14. Dr. Ferree, formerly associate medical director of the American Heart Association, succeeds **Dr. F. M. Foote,** who resigned from the Society to accept the position of Commissioner of the Connecticut Department of Health. Dr. Foote had been with the Society since 1946.

George C. Connor has been named Regional Vice-President of Sylvania Electric Products, Inc., with responsibility for the direction of the company's marketing activities in the East, with headquarters at Sylvania's offices in New York City. Prior to this appointment, Mr. Connor had been general sales manager—photolamps for seven years.

Harry L. Kohn has joined Lighting Services, Inc., New York, N. Y., as chief engineer. Prior to this connection, Mr. Kohn was electrical engineer for Lighting by Feder, New York, N. Y.

Dan E. Rosenthal has been named Executive Director of the Electrical Leagues of New York, Inc., according to a recent announcement by **Carroll L. O'Shea,** President of the organization. Mr. Rosenthal's former connections were as Executive Secretary of the St. Louis Electrical Board of Trade and Managing Director of the Nebraska-Iowa Electrical Council, Inc.

Baxter Sharp, Jr., San Jose, Calif., has been signed as sales representative for the San Francisco area by Moe Light Division of Thomas Industries, Inc. Prior to his association with Thomas, Mr. Sharp was a factory representative in the industrial rubber and safety equipment fields.

Deaths

F. L. Cator, Hubert Davies & Co., Ltd., Johannesburg, South Africa.

William H. Heim, Eastern Pennsylvania Section.

NEW MEMBERS

At the meeting of the I.E.S. Council Executive Committee on October 15, 1959, the following were elected to membership. Names marked * are transfers from Associate Member Grade.

Alabama Section

Members:

*Ledbetter, M. P., Turner Supply Co., Mobile, Ala.

*Mathews, L. O., Jr., Mathews Electrical Service, Mobile, Ala.

Associate Members:

Huston, G. W., Huston Electric Supply Co., Inc., Mobile, Ala.

Lark, J. W., 1119 Vivian Drive, Mobile, Ala.

Terrill, J. D., McGowin-Lyons Hardware & Supply Co., Mobile, Ala.

Alamo Section

Associate Members:

Cates, J. H., 151 E. Edgewood Place, San Antonio, Texas.

McGinley, C. P., 418 10th St., San Antonio, Texas.

Arizona Section

Associate Members:

Byland, C. H., Arizona Public Service, Phoenix, Ariz.

Christy, H. L., Howard Christy Electric, Phoenix, Ariz.

Ittenbach, Shirley R., 5327 Calle Redonda, Phoenix, Ariz.

Arrowhead Chapter

Associate Member:

Dew, R. A., Southern California Edison Co., San Bernardino, Calif.

Bluenose Chapter

Associate Member:

Miller, Edgar, Miller Electric Sales & Service, Halifax, N. S.

Buckeye Chapter

Members:

Clarke, R. E., General Electric Co., Circleville, Ohio.

Grigg, E. G., General Electric Co., Circleville, Ohio.

Associate Members:

Ballard, Bernice, Columbus & Southern Ohio Electric Co., Columbus, Ohio.

Blair, R. W., Eastmoor Electric Co., Columbus, Ohio.

Brown, K. S., Kenny Brown & Associates, Inc., Columbus, Ohio.

Duvall, S. E., Columbus & Southern Ohio Electric, Columbus, Ohio.

Fischer, J. F., Basic Electric Co., Columbus, Ohio.

Fleming, F. W., Sylvania Electric Products Inc., Columbus, Ohio.

Fridd, R. C., Graybar Electric Co. Inc., Columbus, Ohio.

Gerebenics, J. L., 5709 Foster Ave., Worthington, Ohio.

Gill, C. W., Westinghouse Electric Corp., Columbus, Ohio.

Hauck, R. W., Columbus & Southern Ohio Electric Co., Columbus, Ohio.

Keiser, J. D., Columbus & Southern Ohio Electric Co., Columbus, Ohio.

Knab, C. E., Graybar Electric Co., Inc., Columbus, Ohio.

Lee, Alan, Gordon Bros. of Columbus, Columbus, Ohio.

Long, G. W., McCleery Carpenter Electric Co., Columbus, Ohio.

McClary, A. J., Columbus & Southern Ohio Electric Co., Columbus, Ohio.

Moore, A. H., National Electrical Contractors Association Inc., Columbus, Ohio.

Pace, Claire E., Columbus & Southern Ohio Electric Co., Columbus, Ohio.

Passe, Michael, Ralph J. Kramer, Comer & Passe, Columbus, Ohio.

Powell, E. H., Westinghouse Electric Corp., Columbus, Ohio.

Stillinger, K. L., General Electric Supply Co., Columbus, Ohio.

Tonya, M. L., Basic Electric Corp., Columbus, Ohio.

Trumbo, H. H., Columbus & Southern Ohio Electric Co., Columbus, Ohio.

Student Member:

Tyra, T .D., Jr., Ohio State University, Columbus, Ohio.

Central Florida Section

Associate Members:

Boxall, C. A., Jr., Florida Power Corp., Orlando, Fla.

Watson, D. J., Sylvania Lighting Products Inc., Winter Park, Fla.

Central Illinois Chapter

Member:

*Wineke, J. W., Associate of George P. Wearda, Pekin, Ill.

(Continued on page 48A)

I.E.S. National Technical Conferences

1960 — September 11-16 — Penn Sheraton Hotel, Pittsburgh, Pennsylvania

1961 — September 24-29 — Chase Park Plaza Hotel, St. Louis, Missouri

1962 — September 9-14 — Statler-Hilton Hotel, Dallas, Texas

1963 — September 8-13 — Sheraton-Cadillac Hotel, Detroit, Michigan

CROUSE-HINDS
EXPLOSION-PROOF
MERCURY VAPOR
LIGHTING FIXTURES

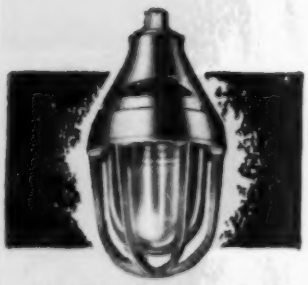
For dependable security at low operating cost in hazardous locations . . .

- *where long burning hours without interruption are involved, month in, month out*
- *where labor cost or trouble of relamping is an important factor*
- *where maximum lighting output calls for maximum economy in power consumption*

The longer life of mercury vapor lamps is well established: 7000 hours, *vs.* 1000 hours for incandescents. Light output is 2.5 times greater; 55 lumens/watt, *vs.* 22 lumens/watt for incandescents.

The new EV's place these economies within easy reach. As with all Crouse-Hinds explosion-proof devices, EV's are heavily constructed to withstand the pressure of internal explosions without rupturing. Gas-tightness *is not* a requirement for their safe performance. Flame-tight joints prevent the escape of flames to flammable atmospheres.

- *For full information, call your Crouse-Hinds distributor, or write for catalog sheet.*



TYPE EVA Explosion-Proof Lighting Fixture

Available with or without guard, or reflector (dome, deep bowl, shallow bowl, angle, or high bay)

250 Watt— National Electrical Code: Class I, Groups C & D

400 Watt— Class I, Group D

CROUSE HINDS

MAIN OFFICE AND FACTORY: SYRACUSE, NEW YORK

Crouse-Hinds Company of Canada, Ltd., Toronto, Ont.

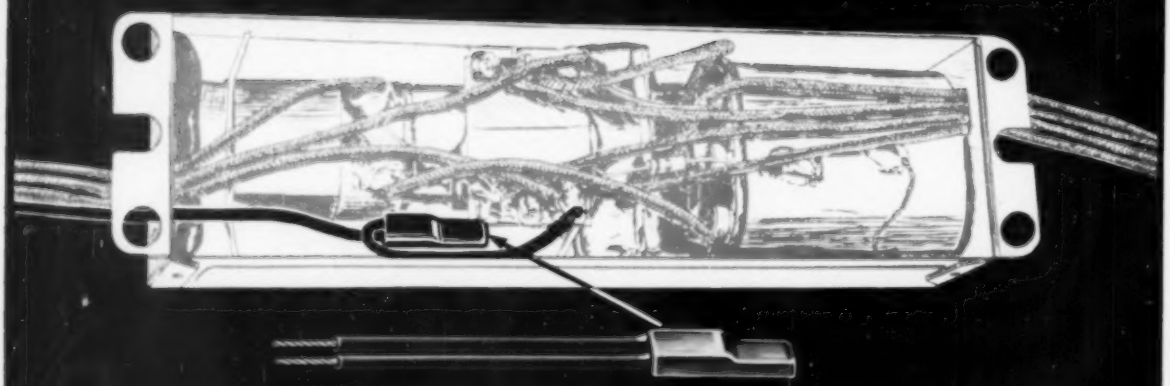
● CONDULET® ELECTRICAL EQUIPMENT (Explosion-Proof and Conventional) ● FLOODLIGHTING
● TRAFFIC CONTROL SYSTEMS ● AIRPORT LIGHTING and WEATHER MEASURING EQUIPMENT

These products are sold exclusively through electrical distributors. For application engineering help, contact one of the following offices: Baton Rouge Birmingham Boston Buffalo Chicago Cincinnati Cleveland Corpus Christi Dallas Denver Detroit Houston Indianapolis Kansas City Los Angeles Milwaukee New Orleans New York Omaha Philadelphia Pittsburgh Portland, Ore. Salt Lake City St. Louis St. Paul San Francisco Seattle Tulsa Washington Resident Representatives: Albany Atlanta Baltimore Charlotte Chattanooga Jacksonville Reading, Pa. Richmond, Va. Shreveport

NOW

You can get Positive Protection Against Dripping Compound, Fires & Violent Failures

By Using Ballasts with Built-in KLIXON Protectors



KLIXON PROTECTOR (actual size)

Built-in KLIXON Protectors keep ballasts operating within a safe temperature range under all conditions. The result . . . no dripping compound, no possible fires or violent failures.

Here's how KLIXON Protectors safeguard ballasts . . . assure full ballast life. Should a fault condition occur, the KLIXON Protector snaps the power "off" when the temperature rises above safe operating level. When the fixture and ballast cool to safe operating temperature, KLIXON turns the current "on" again. There is no annoying flicker . . . maximum light output is assured under safe operating conditions.

If the cause of over temperature is external to the ballast, normal ballast life can be expected when the fault has been corrected. If the cause is failure of a component in the ballast, it is necessary to replace the ballast. However, temperature limits are held to a safe level until it is convenient to make this change.

Klixon Protectors Provide Overheat Protection Against:

Lamp Failure
Lamp Rectification
Improper Installation
Poor Maintenance

Klixon Protectors Provide Overcurrent Protection Due To:

Shorted Condenser
Shorted Primary Coil
Shorted Secondary

Write for specification details.

METALS & CONTROLS

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A DIVISION OF TEXAS INSTRUMENTS INCORPORATED

SPENCER PRODUCTS: Klixon® Inherent Overheat Motor Protectors • Motor Starting Relays • Thermostats • Precision Switches • Circuit Breakers

problem

High-foot-candle levels from recessed fixtures were required for Pereira & Luckman's contemporary design of the new IBM Western Headquarters Building.

solution

The ARGUS LUMINAIRE was designed by Lighting Dynamics. Now in production, it is the first recessed troffer using high output and very high output lamps supplying high-footcandle levels to critical seeing areas in drafting, engineering rooms, laboratories, banks, and offices. ARGUS' clean contemporary lines produce EXCITING ARCHITECTURAL EFFECTS with long parallel strips of unbroken light. This new series comes in a WIDE VARIETY OF WIDTHS AND LENGTHS that completely integrate with ceiling materials. Easy to install. As with all Lighting Dynamic luminaires, the Argus features durable, Bonderized and electrostatic, high-reflectance finishes. FOR MORE COMPLETE INFORMATION fill out the coupon below and mail to Lighting Dynamics, 802 West Whittier Boulevard, Whittier, California; or to Lighting Dynamics, 8700 Ambassador Row, Dallas, Texas.

_____ *Send more information on* ARGUS.

_____ *Send your new catalog.*

NAME _____ PHONE _____

ADDRESS _____ TITLE _____

LIGHTING DYNAMICS

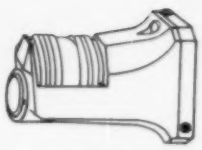
ARGUS as it will be used in the IBM Western Headquarters Building designed by Pereira & Luckman.

Revere Outdoor Lighting Report

Lighting a church exterior

The Problem: To provide distinctive, dramatic lighting for a church exterior. Fixtures must have wide, even light patterns and must be attached to the building itself.

The Solution: Revere No. 3151-A Underneath Floodlights were selected for their wide, flat light pattern. Because they are attached directly to the building, eliminating overhead arms, these underneath light fixtures are unobtrusive and blend in with architectural lines of the building. They are completely weather-tight.

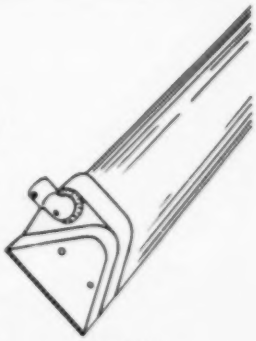


No. 3151-A
Underneath Floodlight

Lighting an automobile dealership

The Problem: To highlight the front of an automobile showroom exterior, showing to best advantage the face of the building and its distinctive identification.

The Solution: A continuous line of Revere Fluoresign luminaires were installed at cornice height, running the entire length of the surface to be lighted. The integral luminaires have an adjustable feature which permits accurate placement of light for smooth, even lighting. Enough spill light occurs on sidewalk for inviting atmosphere.



No. 8600
Fluoresign Luminaire

Lighting a service station

The Problem: To put an extremely high level of light on a service station's pump islands and service areas. Station must be unusually attractive to meet competition.

The Solution: Two Revere No. 7420 luminaires with 1000-watt color-improved lamps are mounted at a 14-foot height on each island. These provide a maintained average of 60 footcandles in the service area. Eliptor floodlights illuminate perimeter. High level of illumination has greatly improved station's competitive position.

No. 7420
Mercury Floodlight

Write for Revere's complete catalog of outdoor lighting equipment.

Revere ELECTRIC MFG. CO.

OUTDOOR LIGHTING

Revere Electric Mfg. Co. • 7420 Lehigh Avenue • Chicago 48, Illinois (In suburban Niles)
Long Distance Phone: NIles 7-6060 • Chicago Phone: SPring 4-1200 • Telegrams: WUX Niles
In Canada: Curtis Lighting, Ltd., Leaside, Toronto, Ontario

FROM THE NATION'S LARGEST MANUFACTURER OF COMMERCIAL AND INDUSTRIAL LIGHTING EQUIPMENT...

NEWS about lighting's most versatile design elements

UNI-FRAME

recessed incandescent lens box line

by

DECIDEDLY BETTER
DAY-BRITE
LIGHTING FIXTURES

A-636

New smaller size for 100-150 watt lamps at lower price!
New diffusing glass bowl!
New matching splay trims!
New application ideas!
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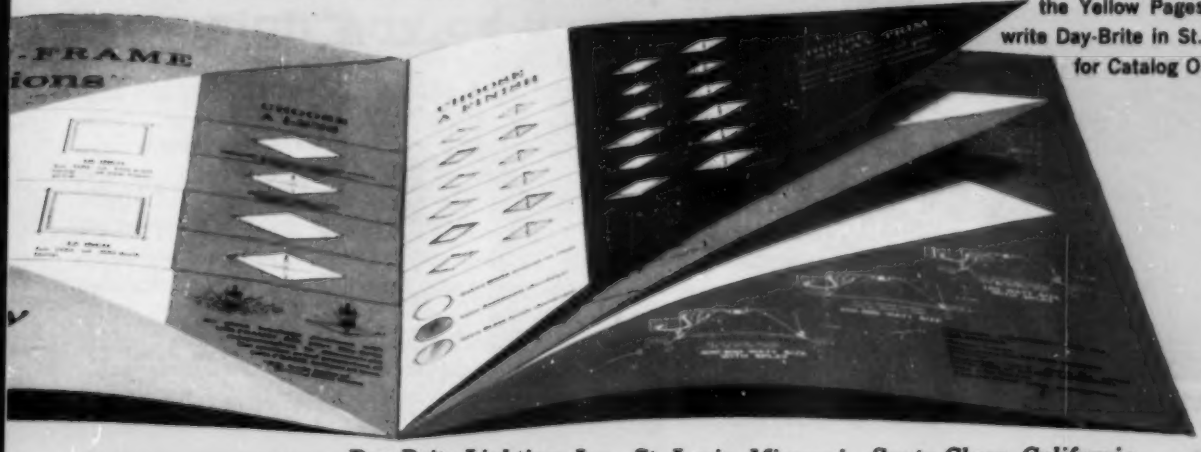
...and IDEAS on "how to" use them



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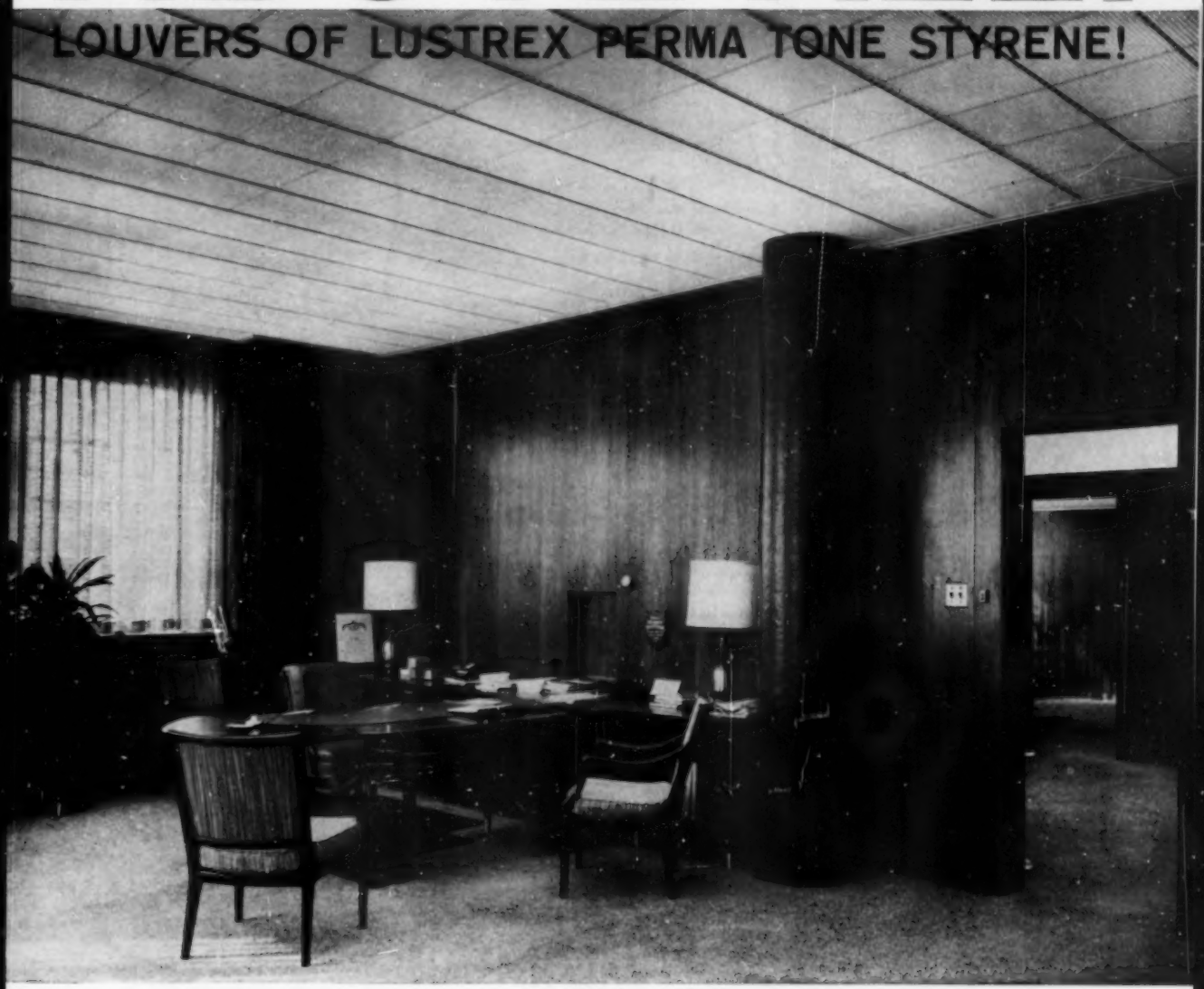

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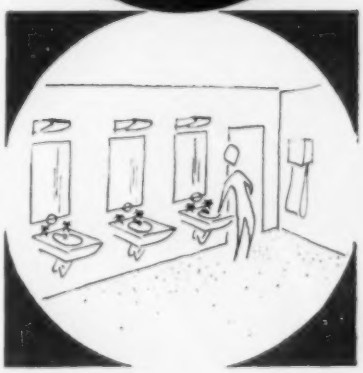

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HATBORO, PENNSYLVANIA
OSborne 5-7200

100% CBM CERTIFIED

Sola ballasts guard your reputation with 100-percent CBM certification. There is no "second line" at Sola.

Every Sola fluorescent ballast for general-lighting service, for which a CBM specification exists, is a CBM-certified ballast—and then some! They top CBM specs by comfortable margins. You can install, furnish, or specify Sola knowing that reserve tolerances—conservatively engineered into every unit—assure full-rated ballast life and light output.

Lamps and fixtures operating with cool, efficient, trouble-free Sola ballasts deliver all the performance demanded by their designers. The man who's buying the light expects nothing less, and it's up to the contractor, the fixture manufacturer, and the engineer to see that he gets it. Sola ballasts guard your reputation. Why not call your district sales engineer and get the facts. ***Sola Electric Co.*** (A Division of Basic Products Corporation) ***4633 W. 16th Street, Chicago 50, Illinois.***

SOLA BALLASTS

HOW CBM ASSURES YOU BETTER BALLAST VALUE

ETL checks 12 to 14 specified ballast characteristics on all Certified types in production by each manufacturer, verifies compliance by test . . . and does it every month!

SPECIFIED performance is checked by test . . . that's why you can always rely on Certified CBM ballasts for dependable lighting service.

What characteristics are checked? The operating qualities which the American Standards Association has determined will give dependable, rated performance from the lamps with which the ballasts are designed to be used. These constitute the CBM Specification and assure:

High power factor • High light output • Positive starting • Rated lamp life • Limit on heat rise • Control for steady light • Quiet operation

From these qualities come practical benefits: Up to 2,500 hours more lamp life than with ordinary ballasts; as much as 40% more light output; and savings on installation . . . with less wire, fewer circuits needed for fixtures CBM equipped . . . fewer fixtures for the same level of light.

For the latest facts on why it pays to specify fixtures equipped with Certified CBM Ballasts, ask us to send you CBM NEWS.

CBM CERTIFIED by ETL

CERTIFIED BALLAST MANUFACTURERS

2112 KEITH BUILDING
CLEVELAND 15, OHIO

Participation in CBM is open to any manufacturer who wishes to qualify

5-49

WITH FINER LIGHTING

Guth

LIGHTING

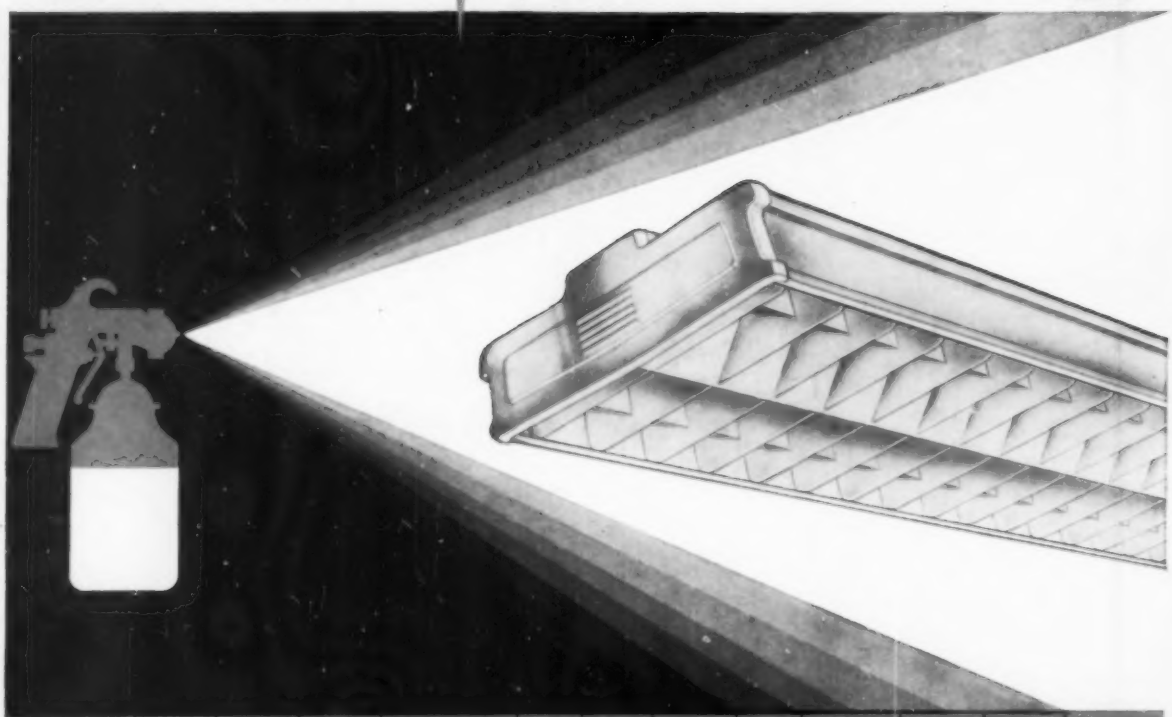
NOW FIRST WITH LUCITE* "ACRYLIC" FIXTURE FINISH

... for greater efficiency—longer lasting beauty—easier maintenance

The same brilliant acrylic-base finish used on millions of late model autos (no polishing in 3 years)... can now be specified on Guth Fluorescents, *at no extra cost!* This means Guth Fixtures offer even more *exclusive* advantages:

1. An extra-rich, sparkling white finish.
2. Maximum reflectivity and light output.
3. Greater resistance to all common stains ... original efficiency lasts longer.
4. Easier maintenance than other enamels. Dirt and dust can't embed itself in this 175% harder finish. Wipes clean quick.
5. A tougher finish—superior resistance to chipping and scratching.
6. 50% less discoloration when exposed to ultraviolet.

MR. SPECIFIER... check the fact chart below... see exactly how much better this new finish is. AND—SPECIFY GUTH FOR YOUR NEXT JOB! *®DuPont



	Adhesion To Metal	Humidity Resist.	Salt Spray Resist.	Fume Resist.		Stain Resist.	Grease Resist.	Hardness	Mar Resist.	Evaporated Adhesion	Baking Color Stability	Heat Resist. (1)	Color Before Exposed to Ultraviolet
				Grease	Tobacco Smoke								
GOOD QUALITY FINISHES	8.0	8.5	8.5	7.5	6.5	5.0	7.0	8.0	8.5	8.5	7.5	5.0	6.0
NEW GUTH LUCITE* FINISH	9.5	10.0	9.5	8.5	9.0	9.0	10.0	22.0	9.5	10.0	8.5	9.0	9.0
PERCENT BETTER	18.75%	17.65%	11.76%	13.33%	38.46%	80.00%	42.86%	175.00%	11.76%	17.65%	13.33%	80.00%	50.00%

(1) 30 min. at 400° F. *®DuPont

THE EDWIN F. GUTH CO. · 2615 WASHINGTON BLVD. · ST. LOUIS 3, MO.